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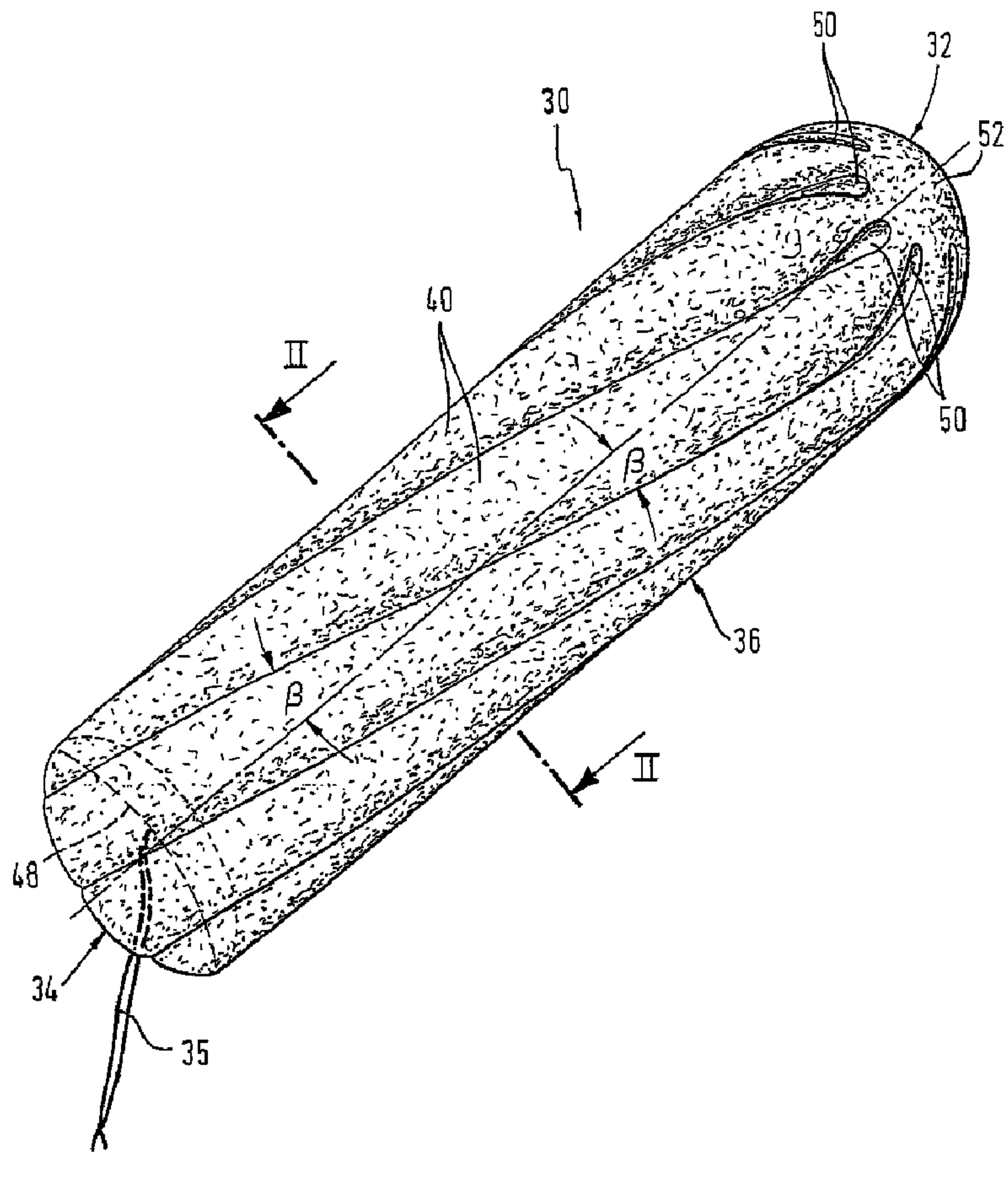
(54) Titre : TAMPON PRESENTANT DES RAINURES SPIRALEES
(54) Title: TAMPON HAVING SPIRALLY SHAPED GROOVES



(57) Abrégé/Abstract:
The present invention is related to a tampon for feminine hygiene, having an insertion end (32), a recovery end (34), a recovery tape (35) and a solid core (38) made of highly compressed fibrous material which is compressed radially with respect to the tampon

(57) Abrégé(suite)/Abstract(continued):
axis at least partially relatively uncompressed longitudinal ribs (40) extend radially outwardly at equal circumferential angle intervals and between the insertion end (32) and the recovery end (34) from said core (38), wherein the longitudinal ribs (40) are separated for one another by longitudinal grooves (42). The longitudinal ribs (40) and the longitudinal grooves (42) are spirally shaped. Furthermore, the invention is related to a method and operated for producing said tampon. A considerable reduction of the risk of leakage after the tampon has been put into use is achieved by extending the time over which the tampon absorbs a body fluid, and by enlarging the surface of the tampon and increasing the fiber quantity available for immediate absorption of body fluid after the introduction of the tampon, in particular in the area of the fiber core.

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(54) **Title:** TAMPON HAVING SPIRALLY SHAPED GROOVES

(57) **Abstract:** The present invention is related to a tampon for feminine hygiene, having an insertion end (32), a recovery end (34), a recovery tape (35) and a solid core (38) made of highly compressed fibrous material which is compressed radially with respect to the tampon axis at least partially relatively uncompressed longitudinal ribs (40) extend radially outwardly at equal circumferential angle intervals and between the insertion end (32) and the recovery end (34) from said core (38), wherein the longitudinal ribs (40) are separated for one another by longitudinal grooves (42). The longitudinal ribs (40) and the longitudinal grooves (42) are spirally shaped. Furthermore, the invention is related to a method and operated for producing said tampon. A considerable reduction of the risk of leakage after the tampon has been put into use is achieved by extending the time over which the tampon absorbs a body fluid, and by enlarging the surface of the tampon and increasing the fiber quantity available for immediate absorption of body fluid after the introduction of the tampon, in particular in the area of the fiber core.

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TAMPON HAVING SPIRALLY SHAPED GROOVES

The invention relates to a tampon for feminine hygiene, and to a method and an apparatus for producing the same, as are described in US Patents no. 5,911,712; 5,813,102 and 5,832,576.

The tampon according to US Patent 5,911,712 has an insertion end, a recovery end with a recovery tape, a central section extending therebetween, and comprises a compressed, generally cylindrical, solid fibrous core, from which relatively uncompressed longitudinal ribs extend radially outward. Each rib is separated from adjacent ribs in the vicinity of the compressed fiber core to an extent which is greater than that extent to which such a rib is separated from an adjacent rib remotely from the compressed fiber core. In this connection, the fiber core is pressed more strongly in the central area than in the area of the recovery end of the tampon. Furthermore, the recovery end of the tampon is provided with a finger recess and the insertion end with a round dome. The approximately circular diameter of the fiber core is up to 5 mm. Finally, the tampon is at least partially surrounded by a liquid-permeable sheathing.

The method described in US Patent 5,813,102 for producing a tampon envisages the following steps: rolling up a length of a continuous fibrous web to form a generally cylindrical tampon blank with a circumferential surface; simultaneous radial pressing of narrow, strip-shaped sections of the circumferential surface of the tampon blank arranged in a spaced manner to form a number of longitudinal grooves which are separated from one another by relatively uncompressed longitudinal ribs which extend radially outward from a relatively compressed core, the core being compressed to a smaller extent in the area of the recovery end of the tampon than in its remaining area; and pressing of outer ends of the longitudinal ribs radially inward to form a soft, smooth circumferential surface, while the relatively uncompressed fibrous structure of the ribs is preserved. The pressing of the narrow circumferential sections of the tampon blank can take place at room temperature, while the pressing of the outer ends of the longitudinal ribs can be carried out at elevated temperature. Furthermore, a finger recess and a round dome can be provided at the recovery end and the insertion end of the tampon respectively. Lastly, a liquid-permeable sheathing is fixed on the fibrous web at least in parts, so as to provide a liquid-permeable layer on at least part of the outer surface of the tampon blank.

The apparatus described in US Patent 5,832,576 for producing a tampon with an insertion end, a recovery end and a recovery tape comprises: a press for preforming a preform with a press axis, an inlet opening, an outlet opening and a plurality of similarly configured press jaws which are arranged in a plane running perpendicularly to the press axis, each press jaw having a pressing head which is oriented radially with respect to the press axis, a pressing shoulder which is laterally adjacent to the pressing head, is offset radially outwardly with respect to the pressing head and has a larger pressing surface than the pressing head, the press jaws being simultaneously concentrically movable in relation to the press axis between a closed position and an opened position, and, in the closed position, the press jaws being supported on one another on mutually opposite longitudinal sides and the radial distance between the press axis and one pressing head at one of the inlet or outlet openings being greater than the distance between the press axis and the pressing head at the other of the two openings, and a stationary shaping tool which is arranged coaxially with respect to the press axis of the press, has an inlet opening which corresponds to an outer diameter of the preform and an outlet opening which corresponds to an outer diameter of the tampon. The radial distance between the pressing heads and the press axis can be greater, if appropriate in a steplike manner, in the direction of the outlet opening of the press. The longitudinal side of each press jaw in each case bounding the pressing shoulder forms a supporting surface which is supported in each case on a sliding surface which is formed by the longitudinal side bounding the pressing head of the adjacent press jaw, parts of the supporting surface and sliding surface bounding a gap which extends radially with respect to the press axis and is open in the direction of the press axis and is closed in the closed state of the press. Moreover, the supporting surfaces on the side of the press jaws arranged in the circumferential direction of the press axis are provided with supporting ribs parallel to the press axis, which, in the closed position of the press, bear against an opposite sliding surface of the adjacent press jaw and form a closed end of said gap between adjacent press jaws, which gap is radial with respect to the press axis. Side flanks of the pressing head of each press jaw converge slightly in the direction of a narrow pressing surface at the radially inner end of each pressing head. The press consists of eight or more press jaws. The stationary shaping tool is a smoothing bush with a partially conical channel which continuously produces the final shape of the tampon and with a clear end section with a cross section which corresponds approximately to the final cross section of the tampon. In this connection, the clear cross section of the inlet opening of the smoothing bush, which lies coaxially opposite the outlet opening of the press, is determined by the cross section of the outlet opening of the press, when the press jaws are closed. Guide ribs inside the smoothing bush correspond in number to the press jaws of the press and occupy the same angular position in relation to the press axis as the pressing heads. The pressing heads of each press jaw project beyond a corresponding end of an associated pressing shoulder, and a round fixing disk surrounding the inlet opening of the smoothing bush is arranged opposite the outlet opening of the press, a front side of the fixing disk perpendicular to the press axis being provided with grooves which are oriented radially with respect to the press axis and in which the pressing heads engage. A revolving disk is arranged behind the outlet opening of the smoothing bush, on which a cylindrical hollow mandrel for transferring the tampon to a packing station is coaxially fixed. The clear cross section of the hollow mandrel corresponds to the smallest clear cross section of the smoothing bush. Lastly, a sleeve-shaped pusher is provided, which has a diameter which is smaller than that of the inlet opening of the press in the open position of the press jaws and serves to feed a tampon blank into the press, a coaxial ejector, which has a diameter which is smaller than the outlet opening of the press in the closed state of the press jaws, being arranged movably to and fro coaxially in the pusher and serving for ejecting the preform out of the press through the smoothing bush into the hollow mandrel.

An object of embodiments of the invention is to improve the tampon, the method and the apparatus as described above in such a manner that the risk of leakage after the tampon has been put into use is reduced considerably by extending the time over which the tampon absorbs body fluid, and by enlarging the surface of the tampon and increasing the fiber quantity available for immediate absorption of body fluid after the introduction of the tampon, in particular in the area of the fiber core.

As a result of the longer distances the body fluid has to cover on account of the spiral design of the longitudinal ribs and of the spiral longitudinal grooves extending between these along the surface of the tampon, and as a result of the associated longer dwell time of the liquid in the spiral longitudinal grooves, the absorption and expansion capacity of the solid fiber core, which ensures the stability or bending resistance of the tampon during introduction of the same into the body cavity, is utilized in a considerably better manner.

Accordingly, an aspect of the invention relates to a tampon for feminine hygiene, having an insertion end, a recovery end, a recovery tape, and a generally solid core made of highly compressed fibrous material which is compressed radially with respect to the tampon axis and from which at least partially relatively uncompressed longitudinal ribs extend radially outward at equal circumferential angle intervals and between the insertion end and the recovery end and are separated from one another by longitudinal grooves, the longitudinal ribs and the longitudinal grooves being spirally shaped.

The spiral longitudinal ribs can each extend over a circumferential angle α of up to at least 150° of the tampon.

According to an advantageous embodiment of the invention, the circumferential surface of the tampon and its fiber core can be curved in a barrel-shaped manner. As a result of the associated lower compression of the fibrous material over the entire cross section of the tampon in the area of its barrel-shaped convexity, not only the fibrous material in the form of the spiral longitudinal ribs surrounding the solid fiber core, but also the in contrast relatively greatly compressed fibrous material of the fiber core, can, when acted on by body fluid, expand more rapidly and moreover absorb a greater quantity of liquid.

According to a further embodiment of the invention, however, the circumferential surface of the tampon and its fiber core can also be substantially cylindrical.

The spiral longitudinal grooves can be open radially to the outside, at least in the area of the compressed cylindrical fiber core. As a result, a particularly large surface and fiber quantity are available for immediate liquid absorption right into the area of the fiber core of the tampon, which is widened in a slightly barrel-shaped manner.

In this connection, the possibility preferably exists that each spiral longitudinal rib of the tampon is separated from adjacent spiral longitudinal ribs in the vicinity of the compressed fiber core to an extent which is greater than that extent to which such a spiral longitudinal rib is separated from an adjacent spiral longitudinal rib remotely from the compressed fiber core.

According to an especially preferred embodiment of the invention, however, the spiral longitudinal grooves can also be closed, at least at the circumferential surface of the tampon. In this case, it is advantageous if opposite side flanks of adjacent spiral longitudinal ribs touch one another only in the area of their radially outer ends and close the spiral longitudinal grooves radially outward, in order to form spiral liquid guide ducts between the fiber core and the closed circumferential surface of the tampon. In this connection, the spiral liquid guide ducts are preferably open at the insertion end and at the recovery end of the tampon.

The method of producing the tampon according to the invention comprises the steps:

- providing a tampon blank of tangled fibrous material;
- compressing the tampon blank on narrow generating lines of its circumferential surface, which are separated from one another by equal circumferential

angles, forming longitudinal grooves and a substantially cylindrical fiber core with a high degree of compression, from which relatively uncompressed longitudinal ribs extend radially outward, the tampon blank being pressed on spiral generating lines in order to form spiral longitudinal grooves and spiral longitudinal ribs parallel thereto in order to enlarge the absorbent surface of the tampon.

The spiral generating lines of the circumferential surface of the tampon blank can each be pressed over a circumferential angle _ of up to at least 150° of the tampon blank. A method step may be preferred, however, in which the spiral generating lines of the circumferential surface of the tampon blank are each pressed over a circumferential angle α of 80° to 120°. Furthermore, it is advantageous to press the fibrous material of the tampon blank under heat action, for example at 80° to 120°C. Moreover, the spiral longitudinal ribs and longitudinal grooves should be smoothed after pressing. While it is true that smoothing the spiral longitudinal grooves and longitudinal ribs at room temperature is preferred, it can also be carried out at a temperature of 80°C to 120°C, if this is desired, for example in consideration of the fiber composition, the size of the tampon and the pressing conditions.

After the pressing of the spiral longitudinal ribs and spiral longitudinal grooves, it is recommended that the radially outer ends of the longitudinal ribs are subjected to a slight concentric pressure, so that the ends of adjacent longitudinal ribs are laid on one another and form a soft, closed circumferential surface of the tampon, the radially outwardly open longitudinal grooves on the circumferential surface of the tampon being closed, so that liquid guide ducts within the closed circumferential surface are produced from the longitudinal grooves, which ducts are preferably open at the insertion end and at the recovery end of the tampon. In this way, a considerable increase in the absorption capacity of the tampon is achieved along with very comfortable introduction for the user.

The preform is advantageously shaped in a single pressing operation, preferably with the application of heat. This is recommended especially when use is made of at least a certain quantity of fibers which, to improve absorption capacity, have an irregular cross section and consequently a strong memory effect.

An apparatus according to the invention for producing the tampon comprises:

- a press having press jaws of equal dimensions which are arranged in a star formation with respect to the press axis x and can be moved synchronously in a common plane radially with respect to the press axis x between their open position and closed position and, in their closed position, are supported on one another on their mutually opposite longitudinal sides;
- a stepped pressing surface on each press jaw,
- the pressing surfaces of the press jaws forming a press opening of round cross section with a length in the range from 40 to 70 mm;
- each pressing surface having a pressing blade which is oriented toward the press opening, and a pressing shoulder, which is arranged only on a specific side flank of the pressing blade and in each case is oriented in the same circumferential direction about the press axis x, the pressing shoulder being offset to the outside in relation to the press axis x with respect to a pressing edge at the free, inner end of the pressing blade, and the area of the pressing shoulder being greater than the pressing edge of the pressing blade of each press jaw, the pressing sur-

face in each case consisting of the pressing blade and the pressing shoulder on each press jaw being spirally shaped.

The pressing blade and the associated pressing shoulder of each press jaw extend over a circumferential angle α of up to at least 150° in the pressing position of the press, with a diameter of the press opening in the range from 8 to 17 mm. The circumferential angle α of the pressing blade and the pressing shoulder of a one-part press jaw is preferably 80° to 120°.

The spiral pressing blades and spiral pressing shoulders of all the press jaws each touch an imaginary envelope surface. In the pressing position of the press jaws, this envelope surface is advantageously barrel-shaped. Only in the clearance position, in which the press opening is widened slightly by moving the press jaws back in the direction of their open position for the ejection of the pressed fiber body, the longitudinal mid-axis of the pressing blades extends radially with respect to the press axis, the center of curvature of the pressing shoulders lying on the press axis and the press jaws touching a circularly cylindrical envelope surface in each case with their pressing surfaces. In this connection, the diameter of the cylindrical envelope surface corresponds at least to the greatest diameter of the barrel-shaped envelope surface of the pressing dimension of the press jaws. As a result, perfect ejection of the preform from the press is guaranteed, the high surface quality of the pressed fiber body thus being preserved.

The 0° vertex of the arcuate curvature of the spiral pressing surface lies on the longitudinal mid-axis of each press jaw, the pressing surface extending from the 0° vertex toward its two ends in complementary fashion in each case over half a circumferential angle of up to at least 75° of the spiral pressing surface of the press jaw.

Half the selected circumferential angle α of the pressing surface of a one-part press jaw is preferably 60°.

Moreover, a longitudinal side bounding the pressing shoulder in each case in each press jaw forms a supporting surface which is supported in each case on a sliding surface which is formed by an opposite longitudinal side of the adjacent press jaw, parts of the supporting surface and of the sliding surface bounding a gap which extends radially with respect to the press axis and, in the closed state of the press, is closed at its end facing the press axis. In this connection, at least one squeezing rib, which runs in parallel with the spiral pressing surface of each press jaw, is advantageously arranged on the supporting surface close to the pressing shoulder, which rib, in the closed state of the press, bears on the opposite sliding surface of the adjacent press jaw. The squeezing rib runs approximately parallel to the spiral pressing surface of each press jaw.

It has proved advantageous to equip the press with an even number of press jaws which should consist of at least four press jaws.

According to a modified embodiment of a press, the press jaws, including their pressing surfaces consisting of pressing blade and pressing shoulder, can be of multi-part design. In this connection, the parts of the press jaws can advantageously be moved to and fro radially with respect to the press axis independently of one another. The press jaws can then be divided in at least one plane which is oriented at right angles to the press axis. A multi-part arrangement of all press jaws as individual pressing segments, which are arranged one after another in the axial direction of the press opening, affords the advantage that the spiral pressing blades and pressing shoulders of the pressing segments following one another in the axial direction can in each case complement one another to form a single spiral pressing surface with a circumferential angle α which is greater than 150°. In this way, the free or open circumferential or absorption surface of the tampon can be additionally enlarged in comparison with the use of a one-piece press jaw.

According to a preferred embodiment, the press jaws can be produced in two parts in the axial direction of the press. In this connection, the dividing plane of the two-part press jaws advantageously intersects the 0° vertex of their pressing surface and the axis of the press approximately at the longitudinal center of the same. The press-jaw halves associated with the outlet side of the press can then advantageously be moved radially outward into the clearance position from their pressing position in relation to the press axis.

Furthermore, each press jaw can be heated, in order to make it possible to handle modern fibers with a strong memory effect.

A positioning web for the recovery tape is arranged at one end of each press jaw, which is located in the area of the outlet end of the press opening, in order to secure the position of the recovery tape wound spirally at the recovery end. The positioning webs engage in grooves of a guide plate with a smoothing bush, which is arranged behind the outlet end of the press.

A conical final shaping channel extends through the one-part guide plate and smoothing bush of the final shaping tool. The clear cross section of the widened inlet opening of the final shaping channel is preferably dimensioned to be greater than the cross section, formed by the pressing shoulders, of the press opening in the clearance position of the press jaws, in order to guarantee perfect movement of the preform through the smoothing bush.

Spiral smoothing ribs are arranged on the conical inner wall of the smoothing bush, the number, cross section, circumferential angle α and angle of inclination β

of which correspond to those of the pressing blades and which are arranged in extension of the spiral pressing blades in their clearance position. The smooth, cylindrical inner wall at the outlet end of the smoothing bush corresponds to the final diameter of the finished pressed tampon.

An endless transport apparatus is connected downstream of the smoothing bush and provided with cylindrical transport sleeves, the diameter of which is dimensioned to be greater than the diameter of the outlet opening of the smoothing bush and which are fixed to the transport apparatus at equal intervals and can be moved step by step in front of the outlet opening of the smoothing bush. The inlet opening of each transport sleeve is conically widened in order to guarantee reliable introduction of the tampon from the smoothing bush. Consequently, the tampon, which is rotated about its axis by the spiral pressing surfaces of the press jaws of the press and by the spiral smoothing ribs of the smoothing bush during ejection from the press through the smoothing bush into the guide sleeve of the transport apparatus, can expand on the way into the guide sleeve without squashing the fibrous material and thus retain its high surface quality.

According to an embodiment of the invention, there is provided a tampon for feminine hygiene, having an insertion end, a recovery end, a recovery tape and a solid core made of highly compressed fibrous material which is compressed radially with respect to the tampon axis and from which at least partially relatively uncompressed longitudinal ribs extend radially outward at equal circumferential angle intervals and between the insertion end and the recovery end and are separated from one another by longitudinal grooves, wherein the longitudinal ribs and the longitudinal grooves are spirally shaped; wherein the spiral longitudinal ribs are open radially to the outside, at least in the area of the compressed cylindrical fiber core.

According to an embodiment of the invention, there is provided a method of producing a tampon as described herein, comprising the steps: providing a tampon blank of tangled fibrous material; compressing the tampon blank on narrow generating lines of its circumferential surface, which are separated from one another by equal circumferential angles, forming longitudinal grooves and a substantially cylindrical fiber core with a high degree of compression, from which relatively uncompressed longitudinal ribs extend radially outward, wherein the tampon blank is pressed on spiral generating lines in order to form spiral longitudinal ribs and spiral longitudinal grooves parallel thereto in order to enlarge the absorbent surface of the tampon; wherein the tampon blank is produced from a section of a nonwoven strip which is wound up on itself.

According to an embodiment of the invention, there is provided an apparatus for producing a tampon as described and for implementing the method as described herein, comprising: a press having press jaws of equal dimensions which are arranged in a star formation with respect to the press axis and are moveable synchronously in a common plane radially with respect to the press axis between their open position and closed position and, in their closed position, are supported on one another on their mutually opposite longitudinal sides; a stepped pressing surface on each press jaw, wherein the pressing surfaces of the press jaws form a press opening of round cross section with a length in the range from 40 to 70 mm; each pressing surface has a pressing blade which is oriented toward the press opening, and a pressing shoulder, which is arranged only on a specific side flank of the pressing blade and in each case is oriented in the same circumferential direction about the press axis, the pressing shoulder being offset to the outside in relation to the press axis with respect to a pressing edge at the free, inner end of the pressing blade, and the area of the pressing shoulder being greater than the pressing edge of the pressing blade of each press jaw, the pressing surface in each case consisting of the pressing blade and the pressing shoulder on each press jaw being spirally shaped, and wherein the press jaws, when in the pressing position, touch a barrel-shaped envelope surface with their substantially spiral pressing surface; wherein at least one squeezing rib, which runs in parallel with the spiral pressing surface of each press jaw, is arranged close to an outer edge of the pressing shoulder on the side wall of each press jaw and, in the pressing position of the press, bears on the opposite side wall of the adjacent press jaw, sealing off the gap.

The invention is described in greater detail below with reference to the diagrammatic drawing of illustrative embodiments of the tampon and of the apparatus for implementing the method of producing the tampon, in which:

Fig. 1 shows a tampon with spiral longitudinal ribs and longitudinal groove according to the invention in a perspective illustration;

Fig. 2 shows a cross section of the tampon in Fig. 1 along the line II-II;

Fig. 3 shows an apparatus for producing tampons according to Figs 1 and 2 in a partly sectioned side view;

Fig. 4 shows a cross section through a pressed fiber body or preform in a press along the line IV-IV in Fig. 3;

Fig. 5 shows the front side or inlet side of the press, which is shown in the open state with a tampon blank and in the closed state of the press jaws with a preform;

Fig. 6 shows the press according to Fig. 5 in the closed state;

Fig. 7 shows a press jaw in a rear view;

Fig. 8 shows a perspective rear and side view of the press jaw in Fig. 7;

Fig. 9 shows the press in the pressing dimension with a preform arranged in it, the circumferential surface of which is curved in a barrel-shaped manner, in a central longitudinal section;

Fig. 10 shows the press in an illustration similar to Fig. 9 but in the clearance dimension, with the preform arranged in it, the circumferential surface of which is substantially cylindrical;

Fig. 11 shows a press with divided press jaws in the pressing dimension in a central longitudinal section;

Fig. 12 shows the press in Fig. 11 in the clearance position of the press jaws for ejection of a preform;

Fig. 13 shows a perspective view of the inlet side of a final shaping tool;

Fig. 14 shows a detail XIII of Fig. 3 on larger scale with a view of a tampon, and

Fig. 15 shows a detail Z of Fig. 14 in a greatly enlarged illustration.

Fig. 1 illustrates a substantially cylindrical tampon 30 for feminine hygiene, having an insertion end 32, a recovery end 34, a longitudinal section 36 lying therebetween, and a recovery tape 35. The tampon 30 consists of a compressed, liquid-absorbing, tangled fibrous material made of natural and/or synthetic fibers. The fibrous material contains at least a certain quantity of fibers, for example 25%, which have an irregular, for example non-round or star-shaped, cross section and consequently have a considerably increased memory effect, which increases the absorption capacity of the tampon 30.

The tampon 30 is provided with a number of longitudinal ribs 40, in the present case eight. The longitudinal ribs 40 are curved spirally or helically in the axial direction between the insertion end 32 and the recovery end 34 and in each case extend over 120° of the tampon circumference in the case of a diameter of the tampon 30 of 13 mm. However, the circumferential angle α can, depending also on the dimensions of the tampon, be selected in the range of up to at least 150°, when one-part press jaws are used preferably in the range of 80° to 120° of the tampon 30. The number of longitudinal ribs 40 can vary, for example depending on the diameter of the tampon and/or the type of absorption material, but should preferably be an even number not less than four or six.

According to Fig. 2, the tampon 30 has a compressed, central, solid, generally cylindrical fiber core 38 with a high degree of compression, which ensures the stability or bending resistance of the tampon 30 during digital introduction of the tampon 30 into a body cavity. The eight longitudinal ribs 40 are relatively uncompressed and have, in particular on a circumferential surface 46 of the tampon 30, a soft fibrous structure. The longitudinal ribs 40 extend radially outward at equal circumferential angle intervals from this solid fiber core 38. As shown in Fig. 2, the spiral longitudinal ribs 40 are separated from one another by eight correspondingly spiral longitudinal grooves 42 which are open radially to the outside at least in the area of the compressed cylindrical fiber core 38. The longitudinal grooves 42 are closed at least at the circumferential surface 46 of the tampon 30 by virtue of the fact that side flanks 44 of adjacent longitudinal ribs 40 touch one another essentially only in the area of their radially outer ends and form the soft, closed, approximately cylindrical circumferential surface 46 of the tampon 30. This closed, soft circumferential surface 46 of the tampon 30 makes possible more gentle and therefore more pleasant introduction of the tampon 30 into the body cavity and a high absorption capacity of the same.

As a result of the fact that the outer ends lying against one another of the side flanks 44 of adjacent longitudinal ribs 40 close the longitudinal grooves 42 only at the circumferential surface 46 of the tampon 30, the longitudinal grooves 42 form in each case eight closed spiral guide ducts 50 (Fig. 2) which are in each case preferably open only at the insertion end 32 and at the recovery end 34 (the openings at the insertion end 32 are visible in Fig. 1). These guide ducts 50 each have a drop-shaped cross section which is largest at the fiber core 38 and tapers radially outwardly to the place in which the adjacent longitudinal ribs 40 lie against one another with the radially outer ends of their side flanks 44. Immediately after the introduction of the tampon 30 into the body cavity, these spiral guide ducts 50 convey the body fluid to the fiber core 38 also, in order to utilize its fibrous material immediately to increase the absorption capacity and expansion capacity of the tampon 30 and to accelerate the opening of the closed guide ducts 50 radially outwardly. Therefore, the arrangement of the spiral longitudinal ribs 40 and the spiral guide ducts 50 or longitudinal grooves 42 brings about an enlargement of the surface of the tampon 30 and consequently an extension of the dwell time or absorption time for body fluid, which results in the absorption capacity and expansion capacity of the fiber core 38 being improved considerably. At the same time, a reduction in the weight of fibrous material used in the tampon 30 is thus possible, which allows more economical production of the tampon 30.

The recovery end 34 of the tampon 30 is, as is known per se, provided with a finger recess 48, which facilitates the insertion of a finger to expand the recovery end 34 and to subsequently introduce the tampon 30 and accelerates the expansion of the tampon 30. For this purpose, the insertion end 32 of the tampon 30 also has a round dome 52, the outer edge of which is smoothed or chamfered. As the approximately hemispherical dome 52 has a relatively short length, the spiral longitudinal ribs 40 and spiral longitudinal grooves 42 can extend over an optimum length of the tampon 30.

The tampon 30 has an approximately circular diameter in the range from 6 to 17 mm, the compressed, approximately cylindrical fiber core 38 having a diameter of up to 5 mm. The tampon 30 is preferably at least partially surrounded by a liquid-permeable sheathing, which is known per se and therefore not shown. This sheathing can consist of, for example, an airlaid nonwoven covering material made of tangled, at least in part thermoplastic, heat-sealing fibers or of a perforated plastic film. In particular when nonwoven covering material is used for the tampon sheathing, it is recommended that the circumferential surface 46 of the tampon 30 is smoothed, which can, if appropriate, be carried out with the application of heat. Such a sheathing improves the comfort of introduction and prevents fibers being detached during introduction or removal of the tampon 30 into or from the body cavity. Finally, the tampon 30 can be more weakly radially pressed in the area of its recovery end 34, so that the fibrous material there is less strongly compressed and the expansion of the fibrous material at the recovery end 34 before introduction of the tampon 30 is made easier.

As Fig. 3 shows, an apparatus 60 for producing the tampon 30 described above consists of a number of elements arranged coaxially one behind another, namely a feed and ejection device 62, a star-shaped press 64 with press jaws 66 which have pressed a preform 84 in their closed or pressing position, a final shaping tool 68 and a circulating or rotating transport apparatus 70. The transport apparatus 70 is, for example, a revolver 72, to which transport sleeves 74 are fixed at equal circumferential angles and radii. The revolver 72 can be moved step by step, so that the transport sleeves 74 can be moved successively in front of the outlet end of the final shaping tool 68 to receive in each case a finished tampon 30 ejected from the final shaping tool 68 by the device 62.

The feed and ejection device 62 according to Figs 3 and 10 is known per se and consists of a feed pusher 76 which can be moved to and fro coaxially with respect to a press opening 78 of the press 64. The feed pusher 76 has a circular face 80 with a diameter which corresponds approximately to that of a tampon blank 55 (Fig. 5), preferably of a wound blank, by means of which face the tampon blank 55 can be transferred coaxially into the opened press 64. A bar-shaped ejector 82 is mounted displaceably to and fro relative to the feed pusher 76 coaxially inside the feed pusher 76, the diameter of which ejector is smaller than the press opening 78 in the raised position of the press jaws 66. The ejector 82 serves for, in a single operation, transferring in each case one preform 84 pressed in the press 64 through the final shaping tool 68 into one of the transport sleeves 74 of the revolver 72. In the final shaping tool 68, the preform 84 then takes on the final shape of the finished pressed tampon 30 described above.

Fig. 4 shows a cross section of the preform 84 in Fig. 3. It can be seen that the cross section of the longitudinal ribs 40 is widened radially outwardly in a drop-shaped manner to the circumferential surface 46 of the preform 84. In contrast, the longitudinal grooves 42 extend radially inwardly in a cross-sectionally drop-shaped manner to the fiber core 38, so that they are wider at the foot of the longitudinal ribs 40 than in the area of the circumferential surface 46 of the preform 84. In other words, the distance between mutually opposite side flanks 44 of adjacent longitudinal ribs 40 is smaller at their radially outer ends remote from the fiber core 38 than in the foot area of the longitudinal ribs 40 or at the fiber core 38. Depending on the conditions of use of a tampon, this cross section shown in Fig. 4 with radially outwardly open longitudinal grooves 42 can also be a very suitable solution for the final shape of a tampon, for example if high, immediate absorbency of a tampon is to be the most important factor. If appropriate, such a tampon provided with open longitudinal grooves 42 can likewise be surrounded by a liquid-permeable sheathing.

According to Figs 5 and 6, the press 64 consists of eight identical press jaws 66 which are arranged in a star formation in a common plane at equal angle intervals about and at the same radial distance from the press axis x. The preferably even number of press jaws 66 can vary, for example depending on the weight and the composition of the material intended for the tampon 30, and can also be smaller or greater than eight, although the number should not be under four. The press jaws 66 have the same dimensions and can be moved to and fro synchronously radially with respect to the press axis x between their open position and closed position (see Fig. 5). In the closed or pressing position, the press jaws 66 are in each case supported on one another on their mutually opposite side walls 86, 88, as is explained in greater detail below.

Figs 5 and 6 show the inlet side of the press 64, the press jaws 66 of which are illustrated in the opened and in the closed position in Fig. 5. Each press jaw 66 has a jaw foot 108 with three through-holes 110 for fixing elements (not illustrated) on guide strips (not illustrated either).

The profile of the press jaws 66, which can be seen in the front view of the press 64 in Figs 5 and 6, extends essentially on that side of a longitudinal mid-axis y of each press jaw 66 which is oriented counterclockwise, in an L-shaped manner from the jaw foot 108 to the press opening 78. The profile of each long L-leg 112 is tapered radially in a triangle-like manner toward a short L-leg 114 and, after this taper, merges at its radially inner end into a striking head 116 (Fig. 5) which has a rounded profile and is a component of the strengthened short L-leg 114 which is angled in the clockwise direction as compared with the long L-leg 112. This angling is in the form of a striking recess 118, the round cross-sectional profile of which extends over an arc of approximately 90° in the direction of the press opening 78 and corresponds to the cross-sectional profile of the striking head 116 of the press jaw 66 adjacent in the clockwise direction. The end of the short L-leg 114 lies at a small distance from the press jaw axis y and forms a pressing blade 92.

A longitudinal mid-axis z of the profile of the pressing blade 92 forms with the longitudinal mid-axis y of the associated press jaw 66 an acute angle $\alpha/2$ which in each case opens counterclockwise in relation to the longitudinal mid-axis y of the press jaw 66. This acute angle $\alpha/2$ between the longitudinal mid-axis z of the pressing blade 92 and the longitudinal mid-axis y of the press jaw 66 in Figs 5 and 6 corresponds to half the circumferential angle $\alpha/2$, that is to say 60° in the present case, with which each longitudinal groove 42 extends spirally over the circumferential angle of 120° about the press axis x. It follows from this that the profile of the other, rear end (not visible in Figs 5 and 6) of the same press jaw 66 is curved in the clockwise direction as compared with the front press jaw profile visible in Figs 5 and 6, or encloses an angle with the longitudinal mid-axis y of the press jaw 66 concerned which opens in the clockwise direction in Figs 5 and 6 and corresponds to the second half circumferential angle $\alpha/2$ of 60° of the overall circumferential angle α of 120°.

In the long L-legs 112 of the press jaws 66, a blind hole 111 is in each case arranged in the vicinity of the pressing blade 92 for receiving a heating element. The blind holes 111 are positioned in the best possible manner in order to bring about optimum heating of each press jaw 66. The temperature of the press jaws 66 is in the range from 80°C to 120°C and is regulated by means of electronic pulses while observing as small as possible a tolerance range. Each press jaw 66 has its own temperature sensor. The thermal insulation of each press jaw 66 consists of a synthetic material made by the company Ensinger GmbH, 71154 Nufringen, Germany, which is resistant to high temperature and high pressure or compressive force. By heating the press jaws 66, it is possible to reduce the memory effect of modern, highly absorbent, greatly expanding fibrous materials, which occurs after the tampon 30 has been finished. By means of the heated press jaws 66, the surface of the tampon 30 is simultaneously smoothed during pressing and pushing out, and a qualitatively improved surface is produced even in tampons of low weight, the stability of the tampon 30 being preserved. The memory effect of the fibrous material becomes effective again when the fibrous material of the tampon 30 is wetted with body fluid.

Figs 7 and 8 show more clearly that each press jaw 66 has an effective pressing surface 90 which is in each case stepped. These pressing surfaces 90 form a press opening 78 of round cross section with a length in the range from 40 mm to 70 mm. Each pressing surface 90 has a pressing blade 92 which is oriented toward the press opening 78, and a pressing shoulder 96 which is arranged only on a specific side flank 44 of the pressing blade 92, that is to say is in each case oriented in the same circumferential direction about the press axis x. The stepping is brought about by virtue of the pressing shoulder 96 being offset to the outside in relation to the press axis x with respect to a pressing edge 94 at the free, inner end of the pressing blade 92. Furthermore, the area of the pressing shoulder 96 is greater than that of the pressing edge 94 of the pressing blade 92 of each press jaw 66. At the same time, the pressing surface 90 in each case consisting of the pressing blade 92 and the pressing shoulder 96 on each press jaw 66 is spirally shaped. The pressing blade 92 and the associated pressing shoulder 96 of each press jaw 66 can extend over a circumferential angle α of up to at least 150° in the closed or pressing position of the press 64, with a diameter of the press opening 78 in the range from 8 to 17 mm. For the press jaws 66 of the present illustrative embodiment, which are formed in one part, a circumferential angle α of the pressing blade 92 and of the pressing shoulder 96 of each press jaw 66 of 80° to 150°, 120° in the present case, is preferred.

According to an important feature of the present invention, provision is made that the press jaws 66, when in a pressing position d in Fig. 9, touch an imaginary barrel-shaped envelope surface 104 with their substantially spiral pressing surface 90. In the pressing position, the pressing blade 92 of each press jaw 66 is oriented essentially although not exactly radially with respect to the press axis x (Figs 5 and 6). The spiral pressing blades 92 and spiral pressing shoulders 96 of all the press jaws 66, when in a clearance position d+ in Fig. 10, each touch an imaginary, substantially circularly cylindrical envelope surface 106. In this connection, the diameter of the cylindrical envelope surface 106 of the clearance dimension d+ of the press jaws 66 corresponds at least to the greatest diameter of the barrel-shaped envelope surface 104 of the pressing dimension d of the press jaws 66. Moreover, provision is made that the 0° vertex of the arcuate curvature 102 of the spiral pressing surface 90 lies on the longitudinal mid-axis y of each press jaw 66, the pressing surface 90 extending toward its two ends in complementary fashion in each case over half a circumferential angle $\alpha/2$ in the range of up to at least 75° of the spiral pressing surface 90 of the press jaw 66. This situation is explained in greater detail below.

The cross section of the pressing blade 92 is drop-shaped, the greatest thickening lying behind the front, narrow, rounded pressing edge 94, and a neck-like contraction 122 being present toward a pressing blade foot 95. The pressing shoulder 96 is arranged eccentrically with respect to the pressing blade 92, in each case only on one specific side surface of two side surfaces 98, 100 of the pressing blade 92 (Fig. 7). This specific side surface 98 or 100 of all the press jaws 66, which adjoins the pressing shoulder 96, is in each case uniformly oriented only in the clockwise direction or counterclockwise. In Figs 5 and 6, which show the front side of the press 64, this side surface 98 of the pressing blade 92 facing toward the pressing shoulder 96 is in each case oriented counterclockwise. In this connection, each pressing shoulder 96 is offset to the outside radially in relation to the press axis x with respect to the narrow pressing edge 94 of the pressing blade 92 by the radial distance between the fiber core 38 and the circumferential surface 46 of the preform 84, and has in the circumferential direction of the press opening 78 a greater area than the pressing edge 94 of the pressing blade 92. The center of curvature of the pressing shoulders 96 of all the press jaws 66 then lies on the axis x of the press 64 only in the clearance position d+ of the press jaws 66.

According to Figs 7 and 8, which show the end face of a press jaw 66 at the rear or outlet side of the press 64, the pressing shoulder 96 is, in contrast, oriented in the clockwise direction. The pressing surface 90, consisting of the pressing blade 92 and the pressing shoulder 96, of each press jaw 66 runs spirally with respect to the press axis x of the press opening 78. In this connection, the pressing blade 92 and the associated pressing shoulder 96 of each press jaw 66 extend over a circumferential angle of 120° of the pressed preform 84 between the two ends of the same. Half the circumferential angle $\alpha/2$ extends in each case over 60° in the present case in a symmetrical or complementary fashion on both sides of the longitudinal mid-axis y of each press jaw 66, so that the press jaw 66 is loaded uniformly over its entire cross section by the pressing forces exerted. As mentioned, the circumferential angle α can generally, however, for example depending on the length and/or the final diameter of the finished tampon, which is 13 mm in the present illustrative embodiment, be up to at least 150°, preferably from 80° to 120°, in the case of one-part press jaws.

The pressing blades 92 and pressing shoulders 96 of each press jaw 66 are not only curved spirally in the longitudinal direction corresponding to the described circumferential angle α of the tampon 30 of 120°, but also have a curvature 102 (Figs 8 and 9) from one end of the press jaw 66 to the other end of the same press jaw 66. This curvature 102 ensues from the fact that the effective pressing surface 90 of each press jaw 66 has to press a spiral longitudinal groove 42 which must in each case extend over a specific circumferential angle of the preform 84, that is to say in the present case over 120° of the circumferential surface of the approximately cylindrical tampon blank 55 at a specific angle of inclination β (Fig. 1). In this connection, the tampon blank 55 (Fig. 5) is as a whole compressed to the pressing dimension d of the preform 84 (Fig. 9), at which each pressing blade 92 is moved beyond the position which is radial with respect to the press axis x. As a result, the clear cross section of the press opening 78 formed by the press jaws 66 widens from both its ends to the longitudinal center of the press jaws 66 or of the press opening 78 formed by these, which consequently assumes a barrel shape in the pressing dimension d or in its pressing position. The envelope surface 104 touching the pressing blades 92 or the pressing shoulders 96 therefore has a slightly barrel-like contour (see Figs 3 and 9) which therefore narrows toward both ends of the press opening 78. Accordingly, the preform 84 also assumes a corresponding shape in the press 64, as can be seen from Figs 3 and 9. In order that the preform 84 can be ejected perfectly, that is to say without damage to the fibrous structure on its surface, from the press 64 while being rotated about its longitudinal axis, the press jaws 66 have to be raised by a specific dimension d+ (Fig. 10). This clearance dimension d+ corresponds at least to the radial distance which separates a chord A, which interconnects the two ends of the pressing blade 92 of a press jaw 66 in Fig. 9 and runs parallel to the press opening

78, from a tangent B in Fig. 9, which is placed against a vertex 0° of the radially outwardly arcuate curvature 102 of a pressing blade 92 and is likewise oriented parallel to the press opening 78. In addition, the clearance dimension d+ can be defined in such a way that it must correspond at least to the greatest diameter of the barrel-shaped envelope surface 104, which is touched by the pressing blades 92 or pressing shoulders 96 in the pressing position. In the case of a tampon 30 with a diameter of 13 mm, this clearance dimension = d + 0.6 mm, by which the press jaws 66 must be moved radially outwardly in order to form, according to Fig. 10, the circularly cylindrical envelope surface 106 of the press opening 78. In this connection, the pressing blades 92 or pressing shoulders 96 touch the circularly cylindrical envelope surface 106 spirally over essentially the entire length in the clearance dimension d+ and consequently form a circularly cylindrical press opening 78 for the ejection of the preform 84.

Figs 5 and 6 show clearly that the neck-shaped contraction 122 of each pressing blade 92 brought about by the drop shape makes possible a greater displacement of the fibrous material approximately radially outwardly during pressing. As a result, the pressing dimension of the press jaws 66 can be reduced to, for example, 4 mm from previously 4.8 mm of the diameter of the fiber core 38 with the same stability and improved absorption capacity and with the soft surface of the tampon 30 being preserved. Furthermore, the width of the rounded pressing edge 94 can be reduced, in order to make it possible for the fibrous material to flow into the radially outwardly created free space of the press opening 78. In this way, the quantity of fiber necessary for producing the fiber core 38 can be reduced in favor of that quantity of fiber which, with the same stability of the tampon, is available for immediate liquid absorption after introduction of the tampon into the body cavity.

In order to be capable of receiving the outwardly displaced fibrous material, the pressing shoulder 96 has a reduced shoulder radius of 6.2 mm in the present illustrative embodiment, compared with 6.55 mm previously, and extends in profile approximately parallel to that side of the press jaw 66 oriented counterclockwise, which merges into the short L-leg 114 and forms the striking head 116.

The outward displacement of the fibrous material achieved by means of this shape of the press jaws 66 makes possible a saving of fibrous material which, in the illustrative embodiment described of a digital tampon 30 with a final diameter of 13 mm and a length of 50 mm, requires the use of only 2.4 g of fibrous material as against 2.7 g of fibrous material previously. In this connection, the fibrous material is composed of 75% highly expansive fibers of irregular, for example star-shaped, cross section and 25% cotton fibers.

It can be seen in particular from Figs 7 and 8 that at least one squeezing rib 120 is provided on an outer side of the pressing shoulder 96 approximately at the level of the latter. In the closed state (pressing dimension d) of the press 64, this squeezing rib 120 of the pressing shoulder 96 and also the striking head 116 of each press jaw 66 bear against the rounded striking recess 118 of the adjacent press jaw 66 in front of the neck-shaped contraction 122 of the pressing blade 92 (Figs 5 and 6). The outer side of each pressing shoulder 96 is provided in Figs 7 and 8 with two parallel squeezing ribs 120 which close a gap 124 oriented approximately radially with respect to the press axis x between the striking head 116 and the striking recess 118 of adjacent press jaws 66 in relation to the press opening 78 and thus in each case in relation to the radially outer side of a spiral longitudinal rib 40 of the preform 84. As a result, the penetration of fibrous material of the tampon blank 55 into the gap 124 between adjacent press jaws 66 is essentially precluded. In the event that fibers penetrate the gap 124 between adjacent press jaws 66, the squeezing ribs 120 cut the staple length of these fibers, so that the fiber residues can fall out of the press 64 and be extracted by suction. A burr-free, smooth, soft, radially outer surface of each spiral longitudinal rib 40 is consequently formed.

Figs 7 and 8 show clearly that at one end face the striking head 116 protrudes further radially inwardly than the pressing blade 92 which is set back by the width of the pressing shoulder 96 with respect to the striking head 116 and is angled in relation to the latter toward the side facing away from the striking head 116. By means of the side walls 86, 88, the press jaws 66 have a cross section normal to their longitudinal mid-axis y which has a shape which is complementary to the circumferential angle α of the spiral press jaw curvature 102, so that the abovementioned uniform distribution of the pressing forces exerted in each case by the press jaws 66 over their entire cross section, that is to say in the direction of the longitudinal mid-axis y of the press jaws 66, is guaranteed.

Fig. 9 illustrates the pressing dimension d of the press 64 diagrammatically. This pressing dimension d corresponds to the barrel-shaped envelope surface 104 which is formed by the spiral pressing blades 92 and pressing shoulders 96 of the press jaws 66 of the press 64 in the closed state or pressing dimension d. This pressing dimension d is, depending on the particular composition and purpose of the tampon 30 concerned, between 6 and 17 mm, 13 mm in the present illustrative embodiment, at the inlet end and at the outlet end of the closed press 64.

During ejection of the preform 84 from the press 64 in this pressing position shown in Fig. 9, the ejection forces would increase greatly as a result of the barrel-shaped cross section of the press opening 78 and of the preform 84 situated therein. The fibers on the surface of the preform 84 would be torn out of the fiber composite, the smooth surface of the preform 84 would be correspondingly damaged and a fiber loss would be caused. For this reason, provision is made that, after the opening of the press 64 to the given clearance dimension d+, the imaginary envelope surface 106 formed or touched by the pressing blades 92 or the pressing shoulders 96 is circularly cylindrical, so that the preform 84 can be ejected from the press 64, virtually without any appreciable resistance, through the final shaping tool 68 into the transport sleeve 74 with simultaneous rotation as a result of the spiral pressing blades 92 engaging in the longitudinal grooves 42 of the preform 84.

In Fig. 10, the spiral pressing blades 92 and pressing shoulders 96 of the press jaws 66 have been moved back radially outwardly by a given clearance dimension d+ of, in the present illustrative embodiment, d + 0.6 mm in relation to the pressing dimension d shown in Fig. 9, in order to enclose or touch the imaginary circularly cylindrical envelope surface 106, which allows the preform 84, which has been pressed in a barrel shape and provided with spiral longitudinal ribs 40 and longitudinal grooves 42, to be pushed out of the press 64 virtually without friction by means of the ejector 82 in the feed pusher 76.

According to Fig. 10, the pressing blades 92 and the pressing shoulders 96 of all the press jaws 66 therefore each touch the imaginary, circularly cylindrical envelope surface 106 on a spiral line over at least a considerable part of their length. That is to say if a lower degree of compression of the fibrous material is desired at the recovery end 34 of the preform 84, the radial distance of the effective pressing edges 94 from the press axis x in the area of the outlet side 79 of the press opening 78 is dimensioned to be somewhat greater, in the closed state of the press jaws 66, than over the remaining longitudinal area of the pressing edges 94, so that this part of the pressing edges 94 would not touch the circularly cylindrical envelope surface 106 in the clearance dimension d+ of the press jaws 66 but would lie slightly radially outside this circularly cylindrical envelope surface 106.

Figs 11 and 12 show an embodiment of a press 130 with multi-part press jaws 132. The divided press jaws 132 can be moved to and fro radially with respect to the press axis x independently of one another. The press jaws 132 are divided in at least one plane T which is oriented at right angles to the press axis x. In the present illustrative embodiment, the press jaws 132 are of two-part design. The dividing plane T of the two-part press jaws 132a, 132b intersects the 0° vertex of their pressing surface 134 and the axis x of the press 130, at the longitudinal center M of the same. The press-jaw halves 132a associated with the outlet side 79 of the press 130 can be moved radially outward into the clearance position d+ from their pressing position d in relation to the press axis x in order to make possible essentially friction-free ejection of the preform 84 from the press (Fig. 12). By multiple division of the press jaws 132 transversely to the press axis x and depending on the number of press jaws 132, the circumferential angle α can be extended beyond 150°. Furthermore, suitable design of the press jaws also makes it possible to modify the outer contour of the tampon depending on the specific tampon requirements.

From the above description of the press jaws 66; 132 according to the invention, it can be stated in summary that the press jaws have to lie diametrically opposite one another in pairs. The present invention also includes the possibility of, in addition to the press jaws 66; 132 described, which produce the fiber core 38, building press jaws into the press 64; 130 which serve purposes other than the production of the fiber core 38. Accordingly, it is possible to use press jaws within the press 64; 130 in order, for example, to stamp patterns or depressions onto or into the surface of the tampon 30 during pressing of the preform 84, which are intended to serve decorative and/or physical purposes.

Figs 13, 14 and 15 show the final shaping tool 68, which consists of a guide plate 140 which is arranged in a stationary manner immediately behind and coaxially with the press 64 and is designed in one piece with a smoothing bush 150 for the preforms 84. The final shaping tool 68 includes a conical final shaping channel 152 for the preforms 84, which extends through the guide plate 140 and the smoothing bush 150. As shown in Fig. 3, the guide plate 140 is arranged immediately in front of the outlet side 79 of the press 64 and, as already described in US Patent 5,911,712, is provided on its side facing the press 64 with a number of grooves 142 corresponding to the number of press jaws 66; 132, which are arranged at the same circumferential angle intervals as the press jaws 66; 132. According to the invention, the grooves 142 extend at a distance from and parallel to the press jaw axis y in the direction of the press opening 78 tangentially with respect to the final shaping channel 152.

It can be seen from Figs 3 and 7 to 12 that the press jaws 66; 132 are each provided at their rear end with a positioning web 160 which projects with respect to the outlet side 79 of the press 64 and in each case engages in one of these grooves 142 with lateral play. The inner, free front end of the positioning webs 160 is a component of the pressing surface 90; 134 of the press jaws 66; 132 and reaches over an axial gap between the press 64; 130 and the final shaping tool 68. In their clearance position d+, the pressing surfaces 90; 134 of the press jaws 66; 132 have a slightly smaller diameter than the inlet opening 154 of the smoothing bush 150 in order that the recovery tape 35, which has previously already been wound spirally at the recovery end 34 of the tampon blank 55 lying at the front in the transport direction x (Figs 14, 15), maintains its centered position at the recovery end 34 by virtue of the positioning webs 160 during pressing and ejection of the tampon 30 from the press 64. From the circular inlet opening 154, the final shaping channel 152 tapers conically to an outlet opening 156 of the smoothing bush 150. In this connection, the conical shape of the smoothing bush 150 is designed in such a manner that as small as possible an ejection force is necessary in order to push the preform 84 out of the press 64 through the smoothing bush 150 and to compress it concentrically to the final dimension of the tampon 30.

Figs 3 and 12 to 14 show that the final shaping tool 68 is provided with spirally shaped, radially inwardly projecting smoothing ribs 170, the number of which corresponds to that of the press jaws 66 and the angle of inclination β of which corresponds to that of the spiral pressing blades 92. The spiral smoothing ribs 170 engage directly in a lightly concentrically pressing and smoothing manner in the spiral longitudinal grooves 42 of the preform 84 leaving the press 64, so that the profile of the preform 84 is preserved but the widening of the cross section of the fiber core 38 caused by the barrel shape of the preform 84 is reduced. The smoothing bush 150 can be heated to a temperature of 80° to 120°C in order, if desired, to optimize the smoothing effect. The smoothing ribs 170 end at a distance in front of the outlet opening 156 of the smoothing bush 150 and merge into a smooth cylindrical end section 172 of the smoothing bush 150. This end section 172 of the smoothing bush 150 has a diameter which corresponds to the diameter of the finished pressed tampon 30. In this smooth cylindrical end section 172 of the smoothing bush 150, the spiral longitudinal grooves 42 of the preform 84, which were open up to here, are closed at the radially outer ends of the side flanks 44 of adjacent spiral longitudinal ribs 40 to the final diameter of the tampon 30 (Fig. 2). In this way, the longitudinal grooves 42 become the liquid guide ducts 50 which are preferably open toward both ends of the tampon 30 (Figs 1 and 2).

In Figs 3, 12 and 13, the transport apparatus 70 is illustrated in an essentially cut-away manner and consists in the present case, as part of a circulating or rotating transport system, of a revolver 72. The revolver 72 is provided with a transverse hole 148, in which the cylindrical transport sleeve 74 fits and is fixed at right angles to the circulating plane of the revolver 72. The transport sleeves 74 are fixed to the revolver 72 at equal circumferential angle intervals and radii, so that in each case one transport sleeve 74 can be moved successively step by step in front of the outlet opening 156 of the smoothing bush 150, in order to feed a finished pressed tampon 30 to a further production station. In this production station (not shown), as is known per se, the insertion end 32 can be provided with the round dome 52 at the same time as the recovery end 34 is provided with the finger recess 48.

As the tampon 30 is subjected to rotation by the spiral press jaws 66 and the spiral smoothing ribs 170 in one single operation on ejection from the press 64 through the smoothing bush 150 into the transport sleeve 74, the cylindrical transport sleeve 74, which is widened conically over a short length at its inlet opening, ensures that the high quality of the surface and of the fibrous structure of the tampon 30 is preserved. In this connection, this delayed laying of the tampon 30 against the cylindrical inner wall of the transport sleeve 74 is caused by the expansion of the fibrous material of the finished pressed tampon 30, that is to say that the diameter of the transport sleeve 74 is dimensioned to be correspondingly greater so as to allow for this expansion of the fibrous material of the tampon 30 immediately after pressing. This is because a positive contact of the tampon 30 against the cylindrical smooth inner wall of the transport sleeve 74 takes place only, as a result of its expansion after pressing, when the tampon 30 concerned has, with its recovery end 34 lying at the front, almost or completely left the outlet opening 156 of the smoothing bush 150.

Furthermore, it can be seen in Fig. 14 that the outlet-side spiral pressing edges 94 of the press jaws 66, which edges lie opposite one another in pairs, form an acute angle which widens to the outlet end 79 of the press 64. As a result, the fiber core 38 is more weakly pressed at the recovery end 34 of the preform 84, so that the fibrous material can be spread slightly before use so as to facilitate digital introduction of the tampon.

In Fig. 15, the incipient expansion of the tampon 30 and its resulting contact against the cylindrical inner wall of the transport sleeve 74 at F is shown especially clearly owing to the enlarged illustration. The fact that the tampon 30 expands only once it is in the transport sleeve 74 on account of the memory effect of the greatly expanding fiber proportion, can be attributed to the high production speed of the tampon. Associated with this is the considerable advantage that the rotary movement to which the tampon 30 is subjected during ejection encounters no appreciable resistance, so that the spiral fibrous structure of the tampon achieved by the invention is preserved in its full extent.

The method of producing the tampon 30 described above comprises, as is known from US Patent 5,832,576, the provision of a strip-shaped tangled-fiber nonwoven, the width of which preferably corresponds approximately to the length of the tampon 30, the separation of a length from the tangled-fiber nonwoven, which is wrapped around with a recovery tape 35, and then the winding up of the length on itself to form an essentially cylindrical tampon blank or wound blank 55. Before winding up, a liquid-permeable layer is applied at least in places to that outer side of the fibrous nonwoven strip which lies on the outside during the manufacture of the tampon blank 55, which layer is fixed at least in places on the outer side of the fibrous nonwoven strip section, preferably by heat sealing. At least one nonwoven layer or a thermoplastic, heat-sealable perforated plastic film can be used, which at least partly sheaths the circumferential surface of the tampon 30, hydrophobic finishing of the sheathing material being preferred.

The preferably cylindrical tampon blank 55, the recovery end 34 of which lies at the front in the feed direction or in the direction of the press axis x, is then introduced coaxially into the press 64 by means of the feed pusher 76. Subsequently, the tampon blank 55 is radially compressed by the press jaws 66 in the press 64 in each case over identical, narrow, spirally shaped sections of identical angle of inclination β of its circumferential surface, which sections are separated from one another by equal circumferential angles. In this way, a preform 84 of barrel-shaped contour is produced, with spirally running longitudinal grooves 42 on a solid fiber core 38 with a high degree of compression which is substantially cylindrical but, because of the barrel shape, is widened in cross section at mid-length, and with longitudinal ribs 40 which extend radially outwardly from the fiber core 38 and run spirally in the longitudinal direction of the preform 84. In this connection, the spirally shaped sections are in each case pressed over a circumferential angle _ of up to at least 150°, preferably over an angle of 80° to 120°, in the present case over an angle of 120°. In the press 64, the fibrous material is preferably subjected to lower radial compressing pressure in the area of the recovery end 34 of the tampon blank 55 than the remaining fibrous material of the tampon blank 55. The tampon blank 55 is, depending on the properties of the fibrous material used, in particular in the event of use being made of highly expansive fibers of irregular cross section with a strong memory effect, pressed at a temperature of the press jaws 66 of 80° to 120°C to the final shape of the tampon 30, in order to achieve the desired dimensional stability of the fibrous material by eliminating the memory effect of the fibers, which immediately becomes effective again on contact with bodily fluid and thus increases the expansion and absorption speed of the tampon 30 with the least possible use of fibrous material.

In the press 64; 130, the tampon blank 55 is compressed in a single pressing operation to form the barrel-shaped preform 84 which, on ejection from the press 64, is at the same time subjected to final shaping in the downstream, if appropriate heatable, smoothing bush 150. This final shaping consists in a weak radial pressure being exerted on the outer ends of the spiral longitudinal ribs 40 and on the spiral longitudinal grooves 42 by the smoothing bush 150, which can be heated to 80°C to 120°C if so desired, and its smoothing ribs 170. This weak radial pressure has the effect that the outer ends of the mutually opposite side flanks 44 of adjacent longitudinal ribs 40 are pressed against one another by the smooth, circular cross section of the final shaping channel 152 in the area of the outlet opening 156 of the smoothing bush 150, so that the longitudinal grooves 42 and thus the outer, approximately cylindrical, soft, closed circumferential surface 46 of the tampon 30 are shaped, and the spiral liquid guide ducts 50 are produced in the area of the now radially outwardly closed longitudinal grooves 42. Furthermore, the smoothing ribs 170 reduce slightly the cross-sectional widening of the fiber core 38 caused by the barrel shape of the preform 84 without the advantage of the rapid liquid absorption and the associated expansion capacity of the variable cross section caused by the barrel shape suffering over the length of the fiber core 38.

On the exit, associated with the rotary movement, of the finished pressed tampon 30 from the smoothing bush 150 into the transport sleeve 74 of the transport apparatus 70, the newly compressed fibrous material expands in relation to the very smooth, cylindrical inner wall of the transport sleeve 74, without frictional resistance, which would impair the surface quality, occurring between the cylindrical, smooth inner wall of the transport sleeve 74 and the fibrous material on the surface of the tampon 30, so that the high quality of this tampon 30 provided with spiral longitudinal ribs 40 and longitudinal grooves 42 is ensured even in the case of mass production. In this connection, it is important that the direction of rotation, in which the length of a fibrous nonwoven, at the end of which a sheathing material is fixed on the outside, is wound up to form a tampon blank 55, is also maintained by the spiral press jaws and smoothing ribs, in order that the embedding of the free, outer end of the sheathing material strip in the surface of the tampon 30 is maintained.

The above description of the invention shows that a dimensionally stable tampon for feminine hygiene with a surface which is enlarged by spiral longitudinal ribs and longitudinal grooves is available, which can be produced at least partly from modern fibers which have a strong memory effect and make possible a saving of fibrous material while the absorption capacity is at least the same.

List of reference numbers

30	tampon
32	insertion end
34	recovery end
35	recovery tape
36	longitudinal section
38	fiber core
40	longitudinal ribs
42	longitudinal grooves
44	side flanks
46	circumferential surface
48	finger recess
50	guide ducts
52	round dome
55	tampon blank
60	apparatus
62	feed and ejection device
64	press
65	end L-shaped press jaw profile
66	press jaw
68	final shaping tool
70	transport apparatus
72	revolver
74	transport sleeves
75	inlet opening (transport sleeve)
76	feed pusher
78	press opening
79	outlet side (press opening)
80	circular face
82	ejector
84	preform
86, 88	side walls of the press jaws
90	effective pressing surface
92	pressing blade

94	pressing edge
95	pressing blade foot
96	pressing shoulder
98, 100	side surfaces of the pressing blade
102	curvature
104	barrel-shaped envelope surface
106	circularly cylindrical envelope surface
108	jaw foot
110	holes
111	blind hole
112	long L-profile leg
114	short L-profile leg
116	striking head
118	striking recess
120	squeezing rib
122	neck-like contraction
124	gap
130	press
132	press jaws
132a, 132b	press jaw halves
134	pressing surface
140	guide plate
142	grooves
144	transverse hole
150	smoothing bush
152	final shaping channel
154	passage opening
156	outlet opening
160	positioning web
170	spiral smoothing ribs
172	end section (smoothing bush)
d	pressing position, pressing dimension

d+	clearance position, clearance dimension
x	press axis
y	longitudinal mid-axis (press jaw 66)
z	longitudinal mid-plane (pressing blade 92)
T	dividing plane
M	longitudinal center
α	circumferential angle
$\alpha/2$	half circumferential angle
β	angle of inclination
A	chord
B	tangent
F	contact point
Z	detail

CLAIMS:

1. A tampon for feminine hygiene, having an insertion end, a recovery end, a recovery tape and a solid core made of highly compressed fibrous material which is compressed radially with respect to the tampon axis and from which at least partially relatively uncompressed longitudinal ribs extend radially outward at equal circumferential angle intervals and between the insertion end and the recovery end and are separated from one another by longitudinal grooves, wherein the longitudinal ribs and the longitudinal grooves are spirally shaped; wherein the spiral longitudinal ribs are open radially to the outside, at least in the area of the compressed cylindrical fiber core.

2. The tampon as claimed in claim 1, wherein a circumferential surface of the tampon and its fiber core are curved in a barrel-shaped manner.

3. The tampon as claimed in claim 1, wherein a circumferential surface of the tampon and its fiber core are substantially cylindrical.

4. The tampon as claimed in claim 1, wherein the spiral longitudinal ribs each extend over a circumferential angle of up to at least 150° of the tampon.

5. The tampon as claimed in claim 4, wherein the circumferential angle is 80° to 120°.

6. The tampon as claimed in claim 1, wherein each of the longitudinal ribs is separated from adjacent longitudinal ribs in the vicinity of the compressed fiber core to an extent which is greater than that extent to which such a longitudinal rib is separated from an adjacent longitudinal rib remotely from the compressed fiber core.

7. The tampon as claimed in claim 1, wherein the spiral longitudinal grooves are closed, at least at the cylindrical circumferential surface of the tampon.

8. The tampon as claimed in claim 7, wherein opposite side flanks of adjacent spiral longitudinal ribs touch one another only in the area of their radially outer ends and close the spiral longitudinal grooves radially outward, in order to form spiral liquid guide ducts between the fiber core and the closed, cylindrical circumferential surface of the tampon.

9. The tampon as claimed in claim 8, wherein the liquid guide ducts are open at the insertion end and at the recovery end of the tampon.

10. The tampon as claimed in claim 1, wherein the tampon is at least partially surrounded by a liquid-permeable sheathing.

11. The tampon as claimed in claim 1, wherein the fiber core is pressed more weakly in the vicinity of the recovery end of the tampon than over its remaining longitudinal area.

12. The tampon as claimed in claim 1, wherein the insertion end of the tampon is provided with a round dome.

13. The tampon as claimed in claim 1, wherein the recovery end of the tampon is provided with a finger recess.

14. The tampon as claimed in claim 1, wherein the tampon has an approximately circular diameter in the range from 6 to 17 mm and a compressed fiber core of up to 5 mm.

15. The tampon as claimed in claim 1, wherein at least the circumferential surface of the tampon is smoothed.

16. The tampon as claimed in claim 15, wherein the tampon is smoothed while applying heat.

17. A method of producing a tampon as claimed in any one of claims 1 to 16, comprising the steps:

providing a tampon blank of tangled fibrous material;

- compressing the tampon blank on narrow generating lines of its circumferential surface, which are separated from one another by equal circumferential angles, forming longitudinal grooves and a substantially cylindrical fiber core with a high degree of compression, from which relatively uncompressed longitudinal ribs extend radially outward, wherein the tampon blank is pressed on spiral generating lines in order to form spiral longitudinal ribs and spiral longitudinal grooves parallel thereto in order to enlarge the absorbent surface of the tampon; wherein the tampon blank is produced from a section of a nonwoven strip which is wound up on itself.

18. The method as claimed in claim 17, wherein the tampon blank is pressed into a tampon, the circumferential surface and fiber core of which are curved radially outwardly in a barrel-shaped manner.

19. The method as claimed in claim 17, wherein the tampon blank is pressed into a tampon, the circumferential surface and fiber core of which are substantially cylindrical.

20. The method as claimed in claim 17, wherein the spiral generating lines of the circumferential surface of the tampon blank are each pressed over a circumferential angle of up to at least 150° of the tampon blank.

21. The method as claimed in claim 20, wherein the spiral generating lines of the circumferential surface of the tampon blank are each pressed over a circumferential angle of 80° to 120°.

22. The method as claimed in claim 17, wherein the fibrous material in the area of the recovery end of the tampon blank is subjected to a lower radial compressing pressure than the remaining fibrous material of the tampon blank.

23. The method as claimed in claim 17, wherein the tampon blank is pressed into the preform at room temperature.

24. The method as claimed in claim 23, wherein the tampon blank is pressed into the preform at a temperature in the range from 80° to 120°C.

25. The method as claimed in claim 17, wherein, after the pressing of the spiral longitudinal ribs and spiral longitudinal grooves, the radially outer ends of the longitudinal ribs are simultaneously subjected to a slight concentric pressure, so that the ends of opposite side flanks of adjacent spiral longitudinal ribs are laid on one another and form a soft, closed circumferential surface of the tampon, the radially outwardly open spiral longitudinal grooves on the circumferential surface of the tampon being closed, so that liquid guide ducts within the closed circumferential surface are produced from the longitudinal grooves.

26. The method as claimed in claim 17, wherein the spiral longitudinal ribs and longitudinal grooves are smoothed before being pressed to the final shape of the tampon.

27. The method as claimed in claim 26, wherein the smoothing of the spiral longitudinal ribs and longitudinal grooves is carried out at 80° to 120°C.

28. The method as claimed in claim 17, wherein a strip of a liquid-permeable layer is applied and fixed at least to the end of that side of the nonwoven section which lies on the outside during the manufacture of the tampon before the nonwoven section is wound up to form the tampon blank, the liquid-permeable layer at least partly sheathing the circumferential surface of the tampon blank.

29. The method as claimed in claim 28, wherein at least one nonwoven layer is used.

30. The method as claimed in claim 28, wherein the layer used is a thermoplastic, perforated plastic film, which at least partly sheaths the final shape of the tampon.

31. The method as claimed in claim 28, wherein the layer is finished so as to be hydrophobic.

32. The method as claimed in claim 17, wherein the section of a nonwoven strip, before being wound up into the tampon blank, is wrapped around with a recovery tape which, during the winding operation, is applied spirally at the recovery end of the tampon blank.

33. The method as claimed in claim 17, wherein at least a proportion of fibers is used which have an irregular cross section, in order to improve the absorption capacity.

34. The method as claimed in claim 17, wherein the insertion end of the tampon is provided with a round dome chamfered off at the outer edge.

35. The method as claimed in claim 17, wherein the recovery end of the tampon is provided with a finger recess.

36. An apparatus for producing a tampon as claimed in any one of claims 1 to 17 and for implementing the method as claimed in any one of claims 18 to 35, comprising:

- a press having press jaws of equal dimensions which are arranged in a star formation with respect to the press axis and are moveable synchronously in a common plane radially with respect to the press axis between their open position and closed position and, in their closed position, are supported on one another on their mutually opposite longitudinal sides;

- a stepped pressing surface on each press jaw, wherein the pressing surfaces of the press jaws form a press opening of round cross section with a length in the range from 40 to 70 mm;

- each pressing surface has a pressing blade which is oriented toward the press opening, and a pressing shoulder, which is arranged only on a specific side flank of the pressing blade and in each case is oriented in the same circumferential direction about the press axis, the pressing shoulder being offset to the outside in relation to the press axis with respect to a pressing edge at the free, inner end of the pressing blade, and the area of the pressing shoulder being greater than the pressing edge of the pressing blade of each press jaw, the pressing surface in each case consisting of the pressing blade and the pressing shoulder on each press jaw being spirally shaped, and wherein the press jaws, when in the pressing position, touch a barrel-shaped envelope surface with their substantially spiral pressing surface; wherein at least one squeezing rib, which runs in parallel with the spiral pressing surface of each press jaw, is arranged close to an outer edge of the pressing shoulder on the side wall of each press jaw and, in the pressing position of the press, bears on the opposite side wall of the adjacent press jaw, sealing off the gap.

37. The apparatus as claimed in claim 36, wherein the pressing blade and the associated pressing shoulder of each press jaw extend over a circumferential angle of up to at least 150° in the closed position of the press, with a diameter of the press opening in the range from 6 to 17 mm.

38. The apparatus as claimed in claim 36, wherein the circumferential angle of the pressing blade and the pressing shoulder of each press jaw is 80° to 120°, when the pressing blade is a one part pressing blade.

39. The apparatus as claimed in claim 36, wherein the spiral pressing blades and spiral pressing shoulders of all the press jaws, when in their clearance position, each touch an imaginary, substantially circularly cylindrical envelope surface.

40. The apparatus as claimed in claim 36, wherein, only in the clearance position of the press jaws, the longitudinal mid-axis of the profile of the spiral pressing blades intersects the axis of the press.

41. The apparatus as claimed in claim 36, wherein only in the clearance position of the press jaws, the center of curvature of the pressing shoulders lies on the axis of the press.

42. The apparatus as claimed in claim 36, wherein the diameter of the circularly cylindrical envelope surface of the clearance dimension of the press jaws corresponds at least to the greatest diameter of the barrel-shaped envelope surface of the pressing dimension of the press jaws.

43. The apparatus as claimed in any one of claims 36 to 42, wherein the 0° vertex of the arcuate curvature of the spiral pressing surface lies on the longitudinal mid-axis of each press jaw, the pressing surface extending toward its two ends in complementary fashion in each case over half a circumferential angle in the range of up to at least 75° of the spiral pressing surface of the press jaw.

44. The apparatus as claimed in claim 43, wherein half the selected circumferential angle is = 60°.

45. The apparatus as claimed in claim 36, wherein the side wall bounding the pressing shoulder in each case in each press jaw forms a supporting surface which is supported in each case on a sliding surface which is formed by an opposite side wall of the adjacent press jaw, parts of the side walls bounding a gap which extends radially with respect to the press axis and, in the pressing position of the press, is closed at its end facing the press axis.

46. The apparatus as claimed in claim 36, wherein the press jaws are multi-part jaws.

47. The apparatus as claimed in claim 46, wherein the parts of the press jaws are moveable to and fro radially with respect to the press axis independently of one another.

48. The apparatus as claimed in any one of claims 36 to 47, wherein the press jaws are divided in at least one plane which is oriented at right angles to the press axis.

49. The apparatus as claimed in claim 48, wherein the press jaws are in two parts.

50. The apparatus as claimed in claim 49, wherein the dividing plane of the press jaw halves intersects the 0° vertex of their pressing surface and the axis of the press, at the longitudinal center of the same.

51. The apparatus as claimed in claim 50, wherein the press-jaw halves associated with the outlet side of the press are moveable radially outward into the clearance position from their pressing position in relation to the press axis.

52. The apparatus as claimed in claim 36, wherein the smallest diameter of the press opening formed by the narrow pressing edges of the pressing blades when the press jaws are closed is about 5 mm.

53. The apparatus as claimed in claim 36, wherein, in the pressing position of the press jaws, the radial distance between the pressing edges formed by the pressing blades and the press axis is greater in the area of the outlet side of the press opening.

54. The apparatus as claimed in claim 36, wherein each press jaw is heatable.

55. The apparatus as claimed in any one of claims 36 to 54, wherein a positioning web for the recovery tape is arranged at one end of each press jaw, at right angles to the press axis, which end is located at the outlet side of the press opening.

56. The apparatus as claimed in claim 55, wherein the positioning web is arranged at a distance from and parallel to the longitudinal mid-axis of each press jaw and extends on the rear end face of the press jaw in the direction of its pressing surface, in such a way that the pressing blade transfers the spirally wound recovery tape into the smoothing bush in the area of the cross section of the fiber core.

57. The apparatus as claimed in claim 36, wherein a final shaping tool comprises a guide plate with a smoothing bush and is arranged behind the press opening, its continuous, conical final shaping channel being widened at an inlet opening and having a diameter which is greater than the diameter of the clearance dimension of the press jaws, and its smooth, circularly cylindrical inner wall at an outlet opening corresponding to the final cross section of the pressed tampon.

58. The apparatus as claimed in any one of claims 55 to 57, wherein the guide plate, on the side facing the press, is provided with grooves which extend approximately tangentially to the inlet opening of the final shaping channel of the final shaping tool and whose number corresponds to the number of press jaws in the press, the positioning webs of the press jaws engaging in the grooves with

lateral play and their inner, free front end being a component of the pressing surface and reaching over an axial gap between the press and the final shaping tool.

59. The apparatus as claimed in claim 58, wherein spiral smoothing ribs are arranged on the conical inner wall of the final shaping channel, their number, cross section and angle of inclination corresponding to that of the pressing blades and said ribs being arranged in direct extension of the spiral pressing blades in their clearance position.

60. The apparatus as claimed in any one of claims 36 to 59, wherein a circulating transport apparatus is connected downstream of the smoothing bush and provided with cylindrical transport sleeves, which are fixed to the transport apparatus at equal intervals and are moveable step by step in front of the outlet opening of the smoothing bush, the cylindrical inner wall of each transport sleeve being larger at its inlet opening than the cylindrical diameter of the finished pressed tampon.

61. The apparatus as claimed in any one of claims 36 to 60, wherein the direction of rotation of the spiral longitudinal ribs and smoothing ribs correspond to the winding direction of the tampon blank, in order to maintain the embedding of the outer end of the tampon sheathing in the surface of the tampon.

Fig. 1

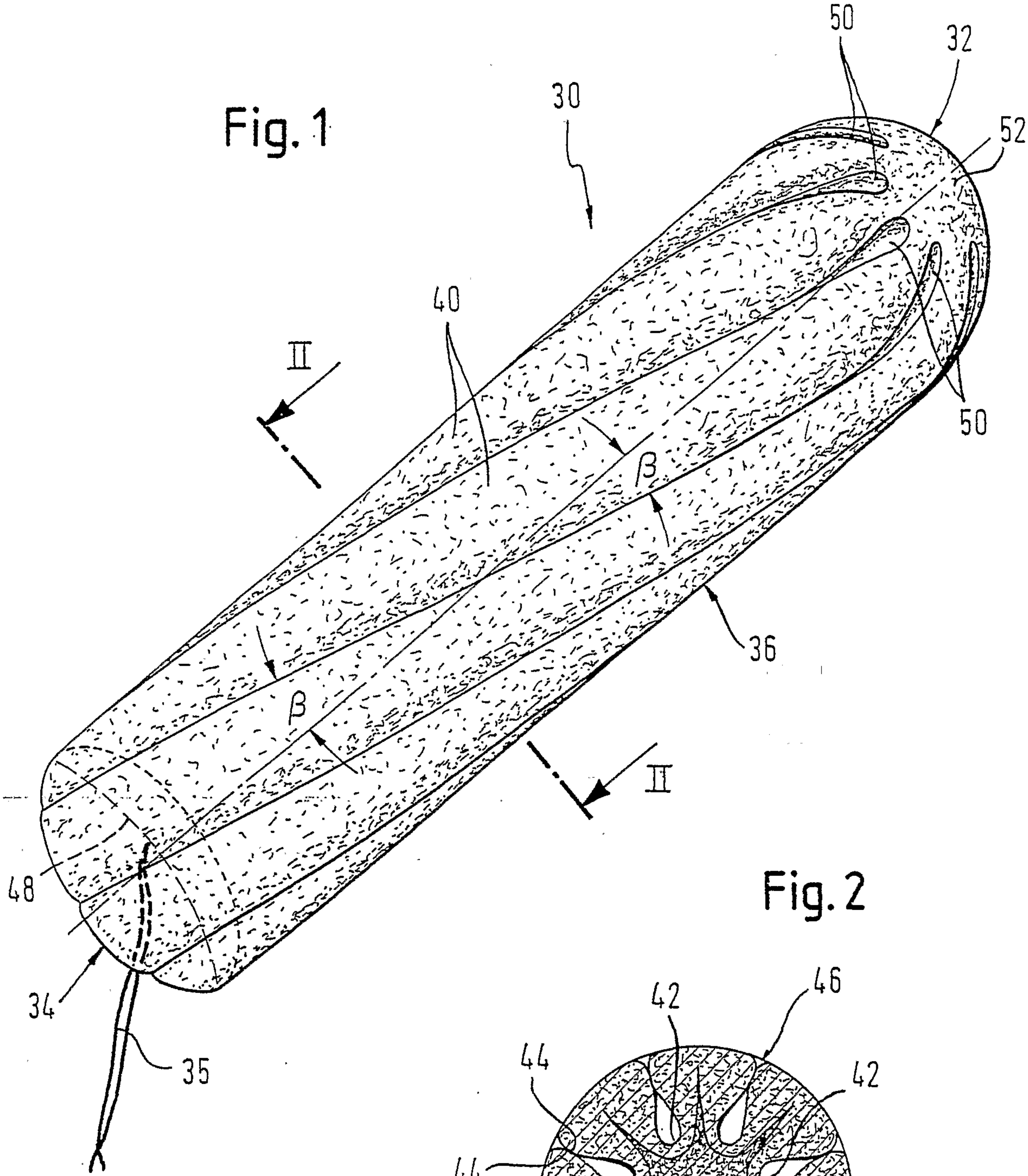


Fig. 2

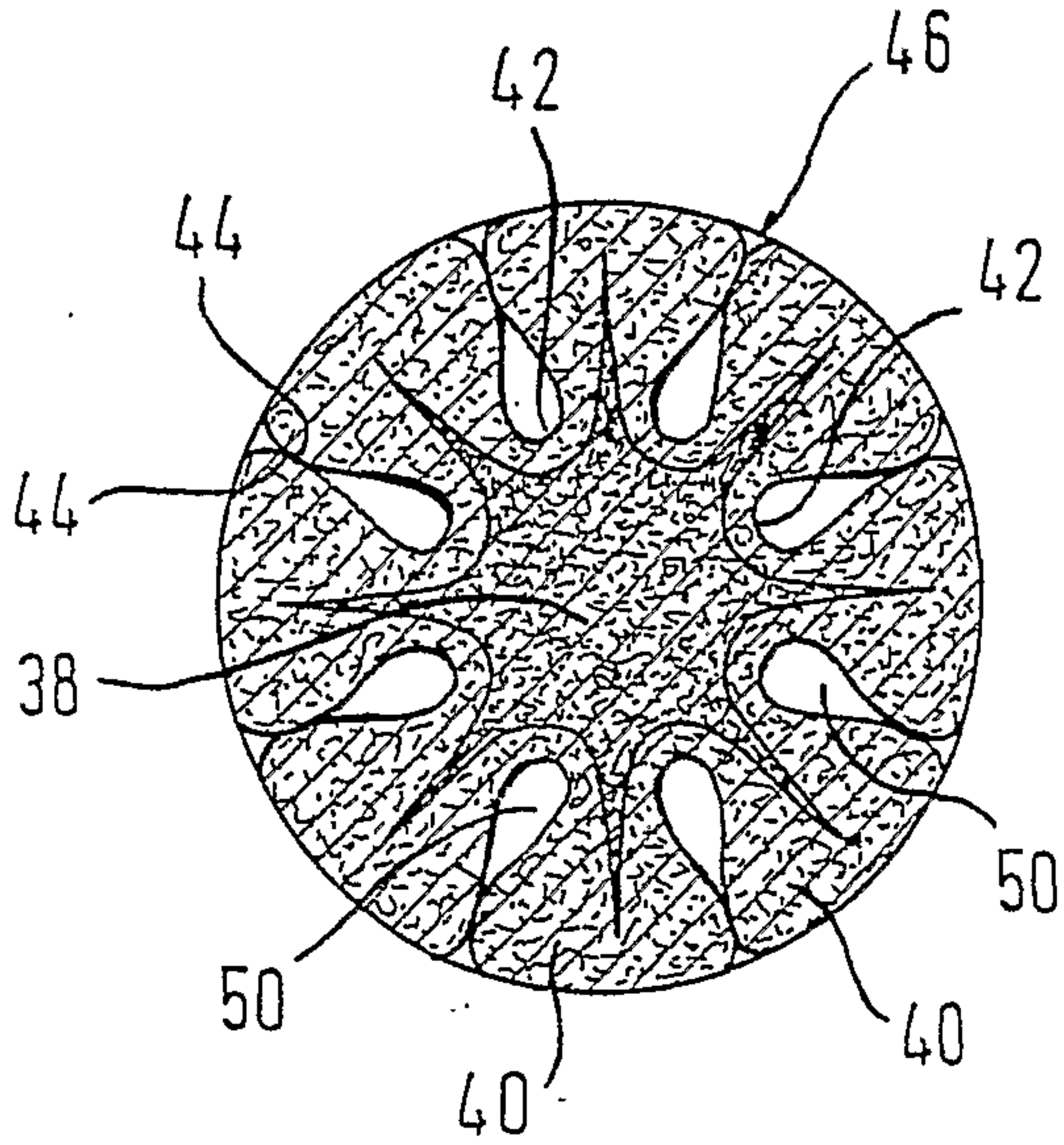
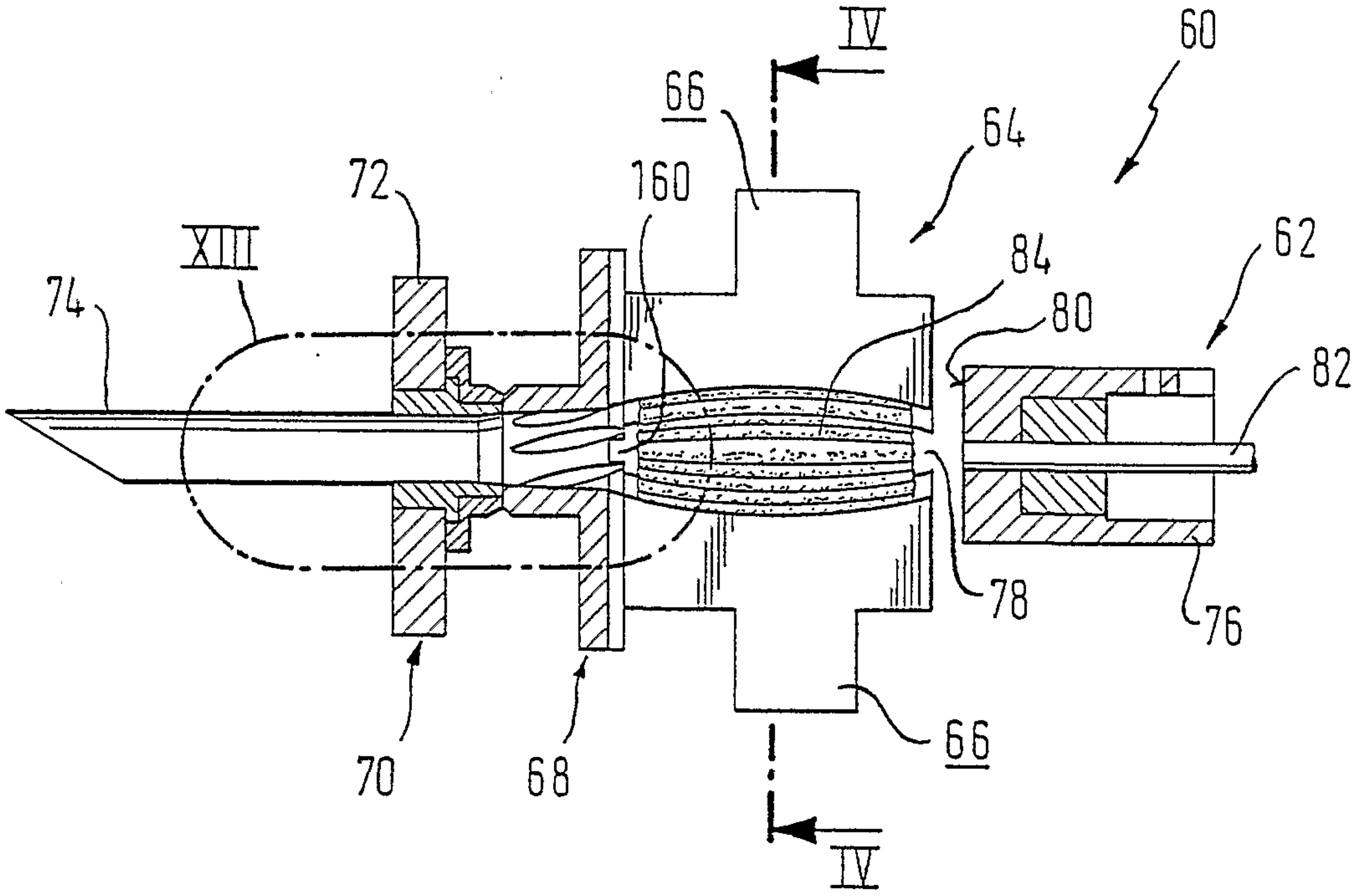


Fig. 3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IV

Fig. 4

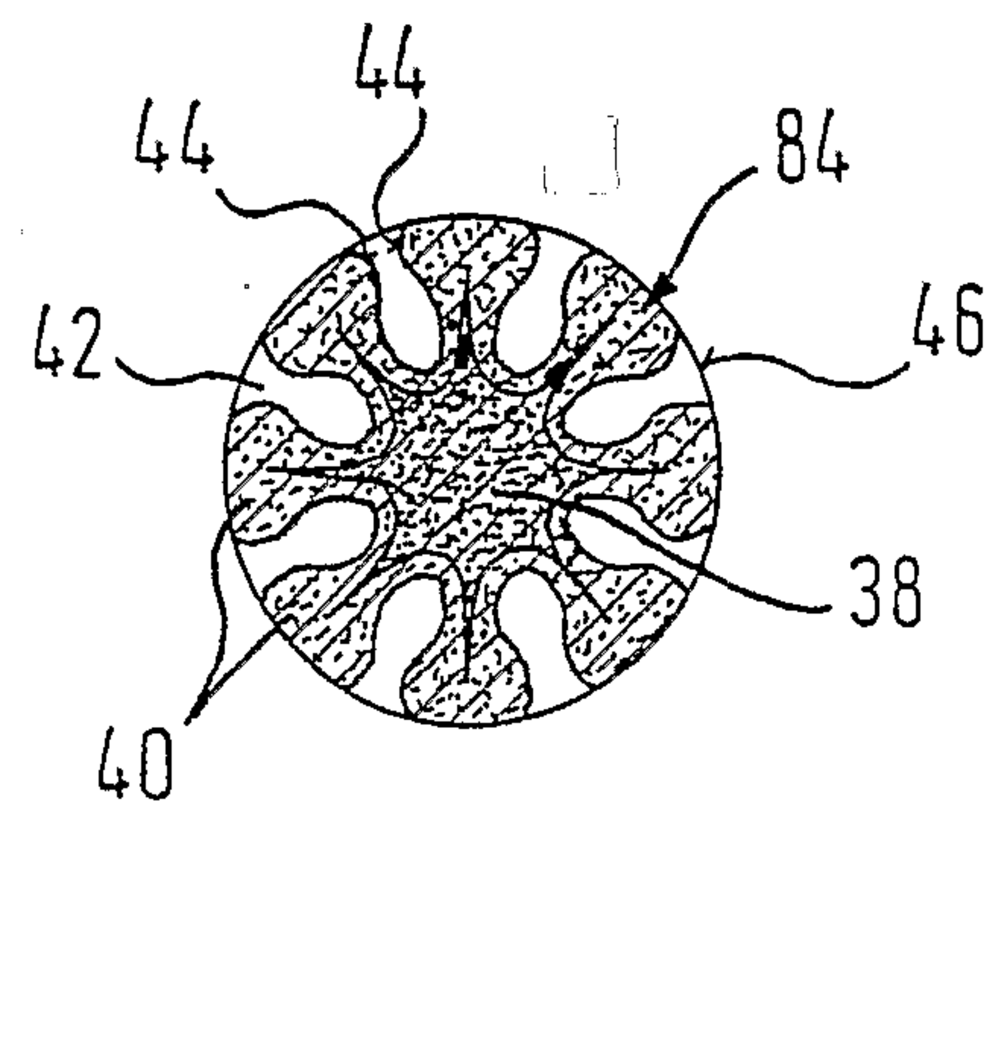
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Fig. 5

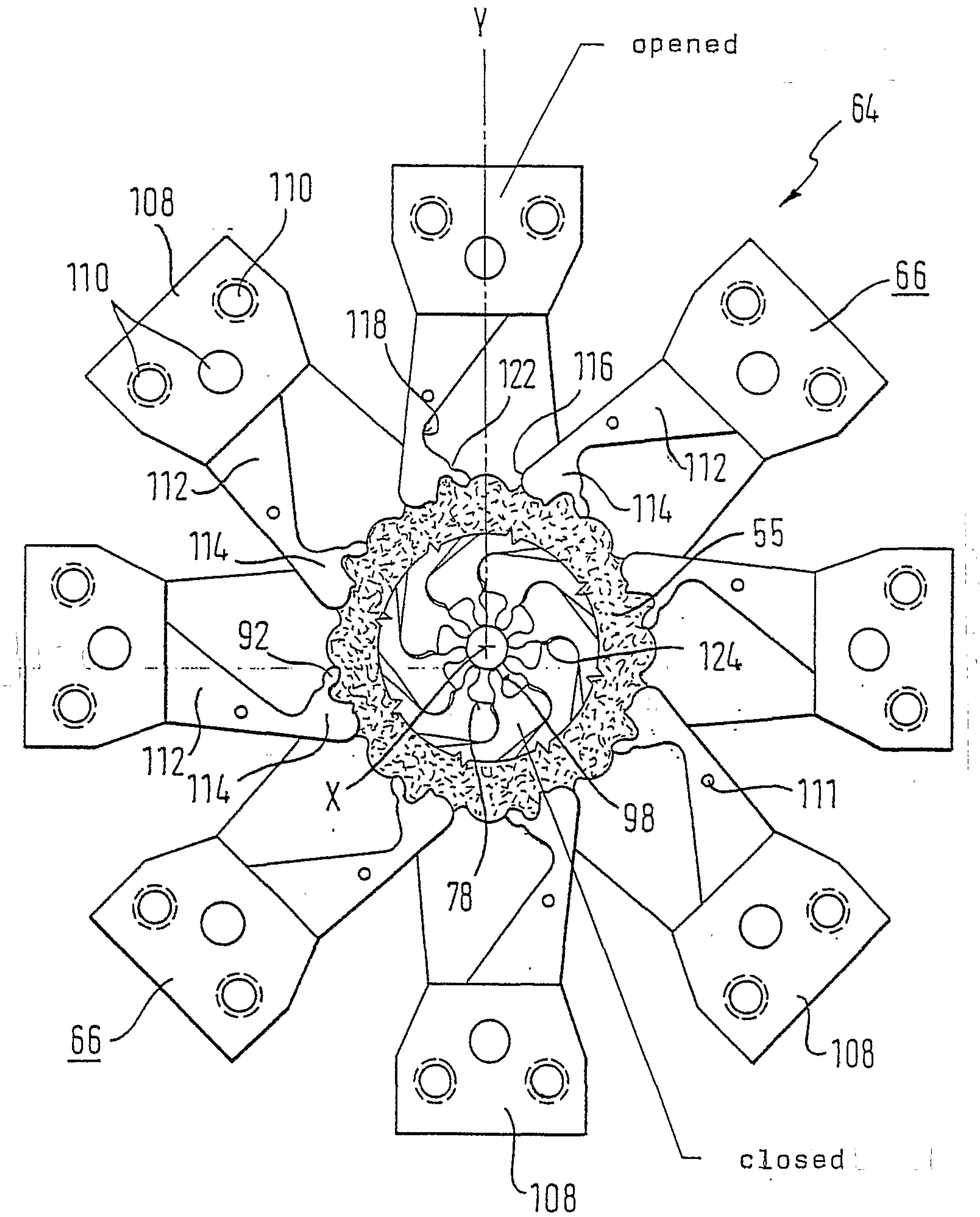
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Fig. 6

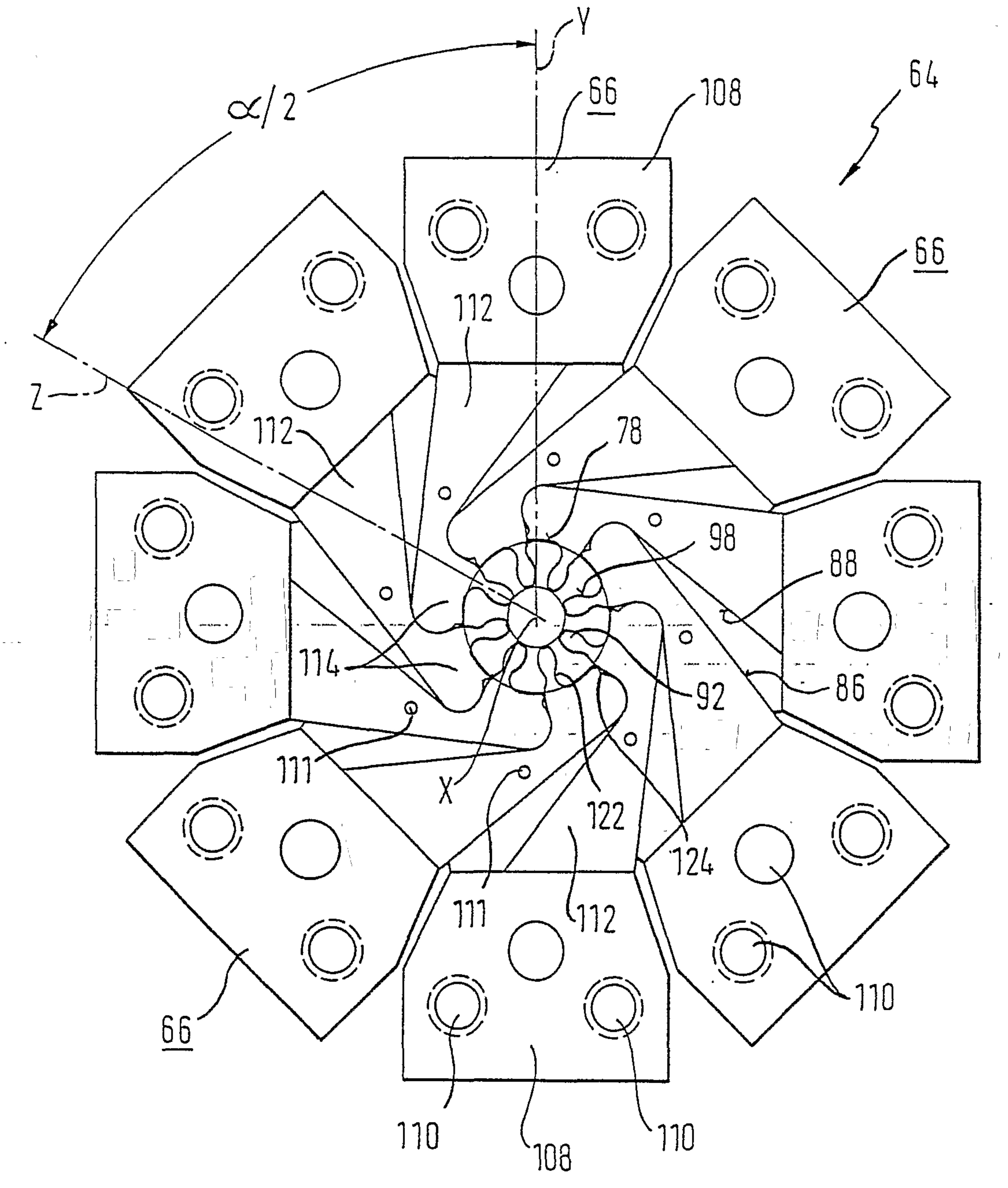
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Fig. 7

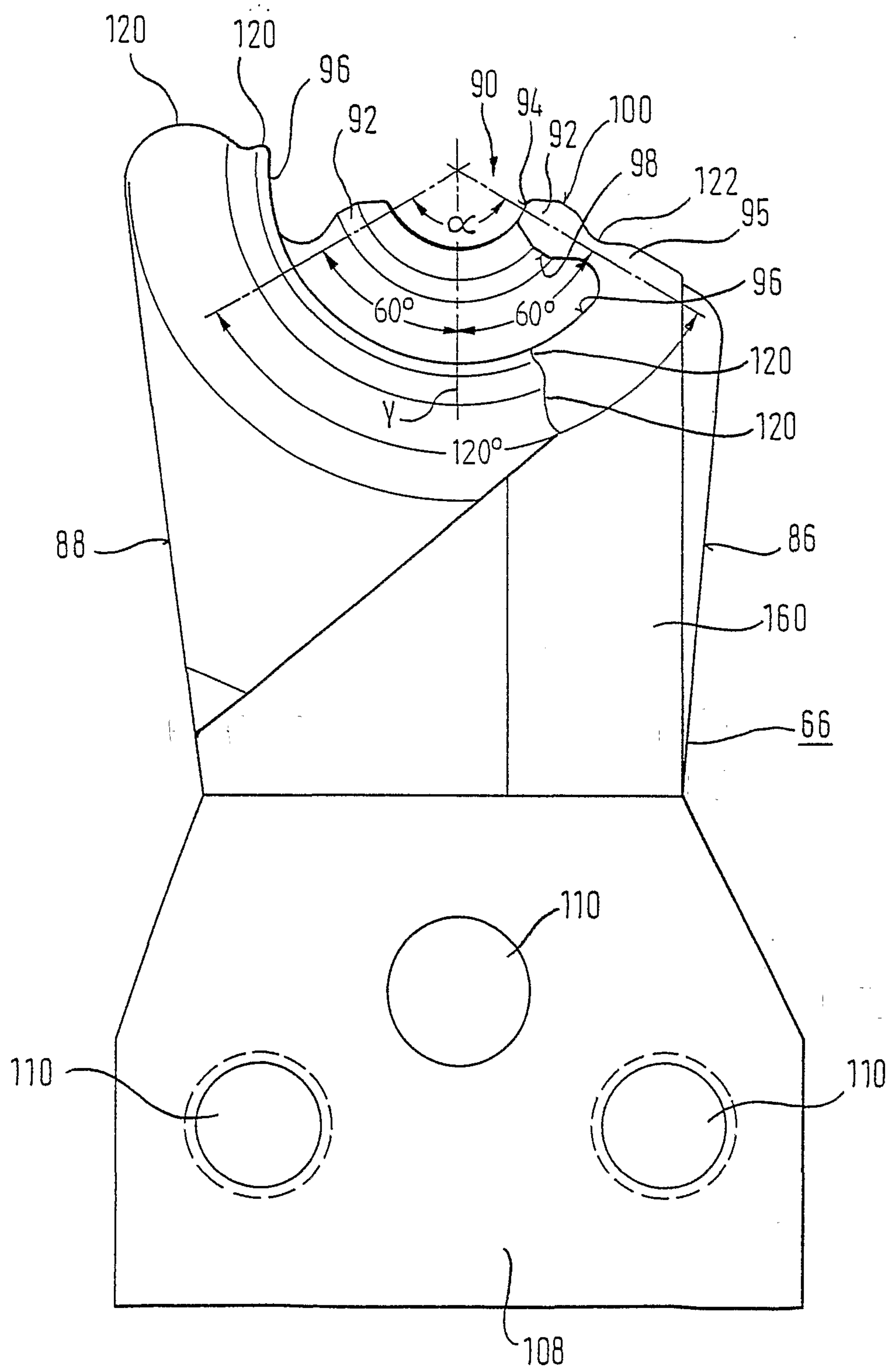
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Fig. 8

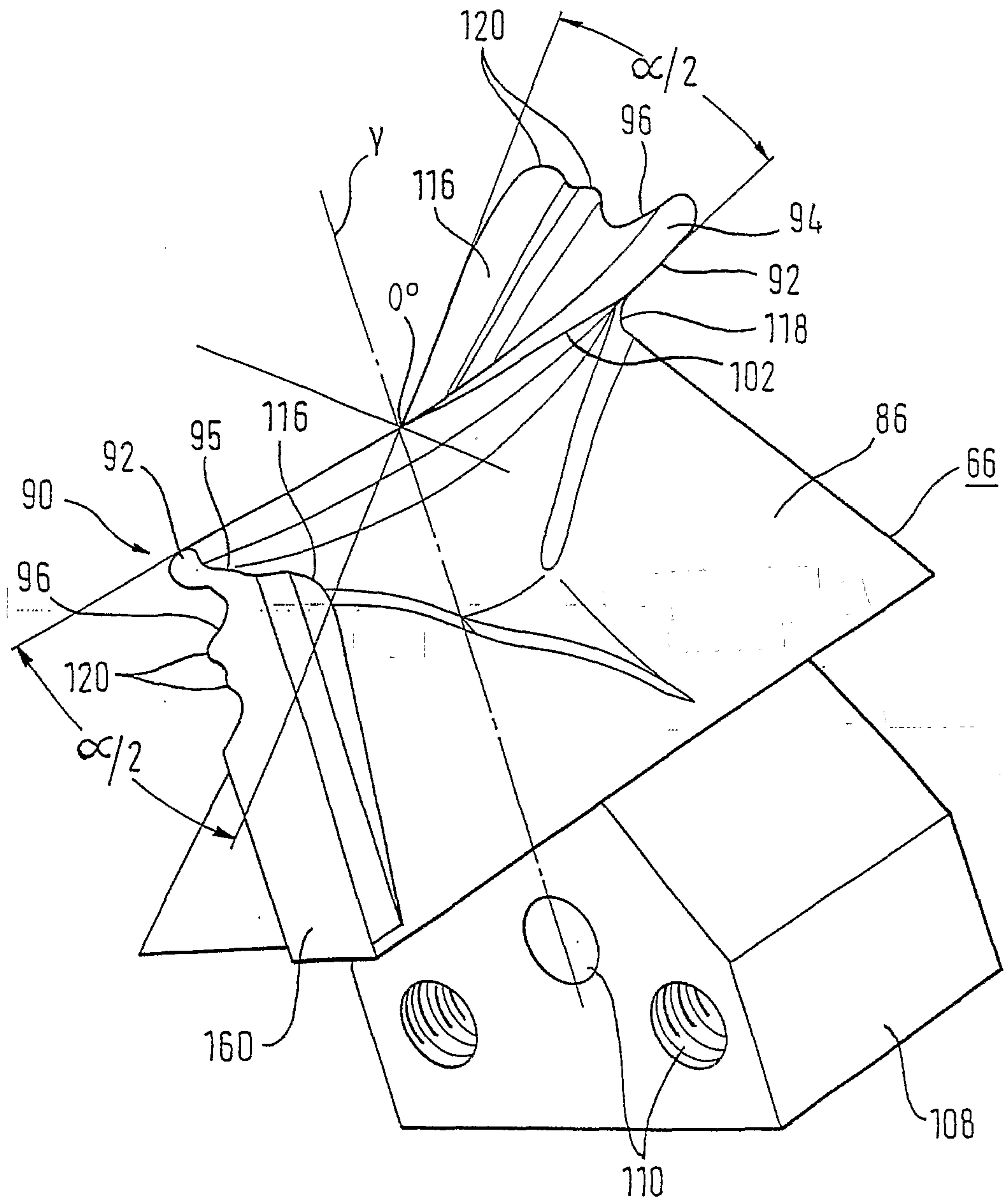
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Fig. 9

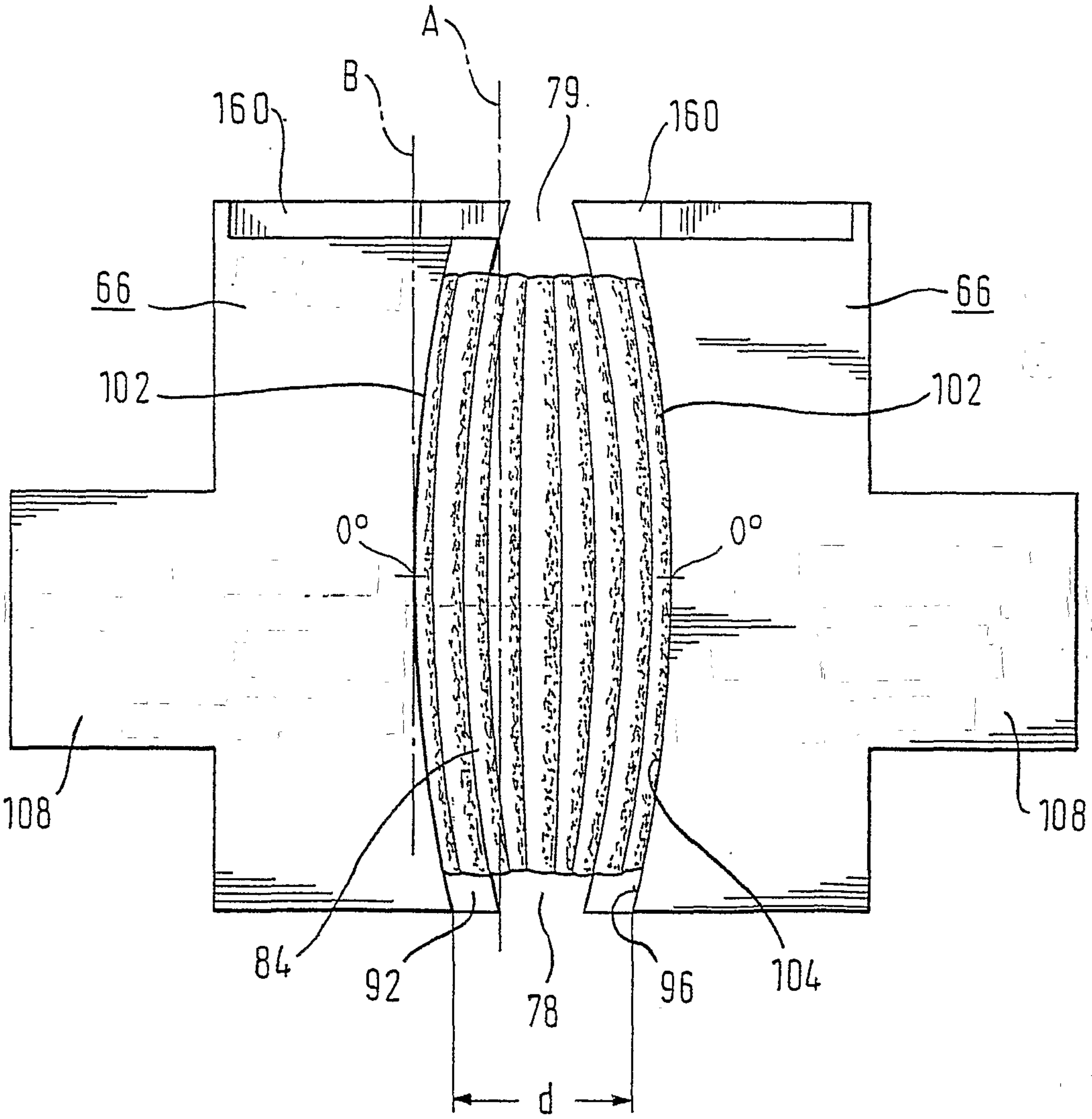


Fig. 10

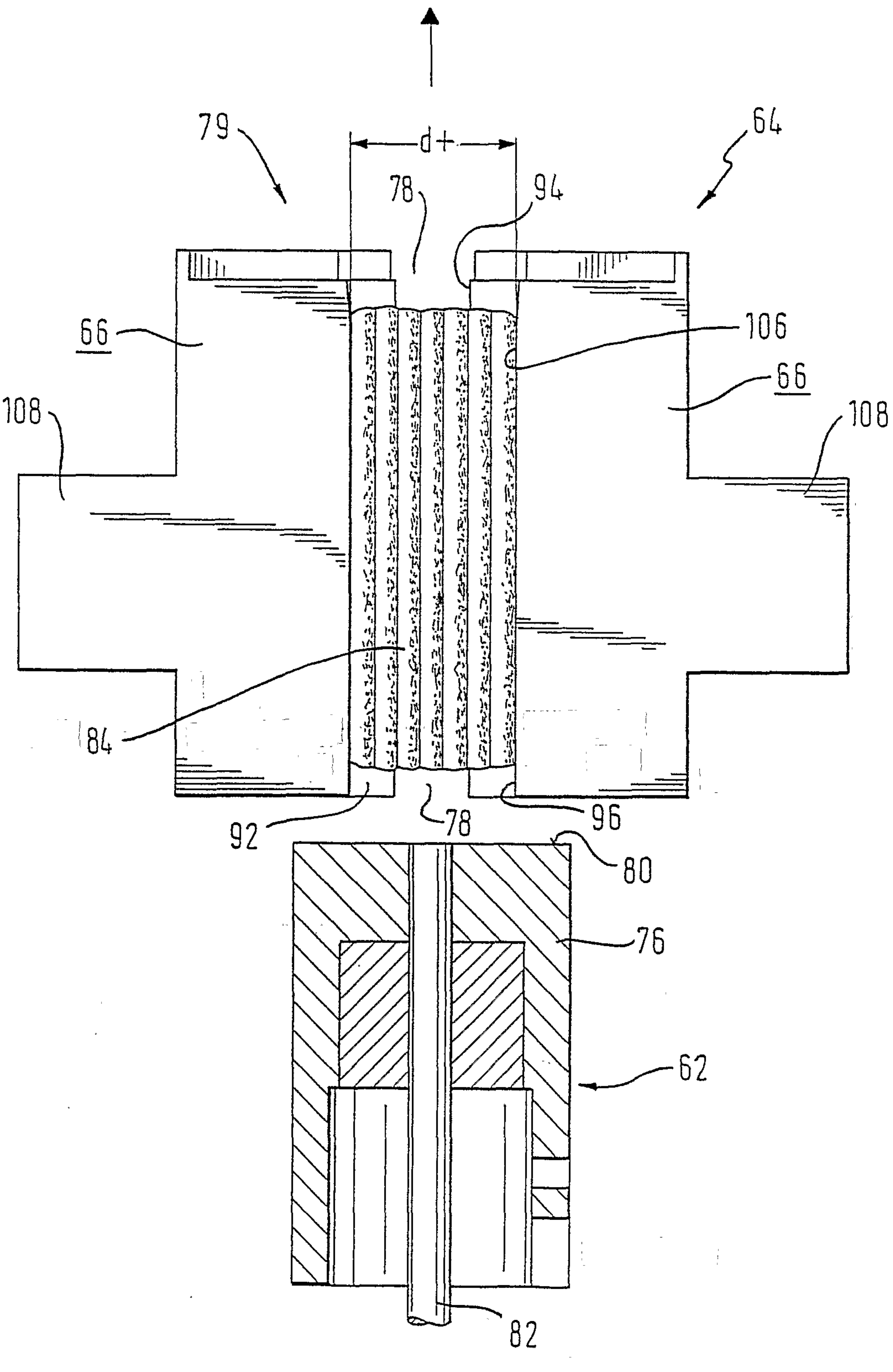


Fig. 11

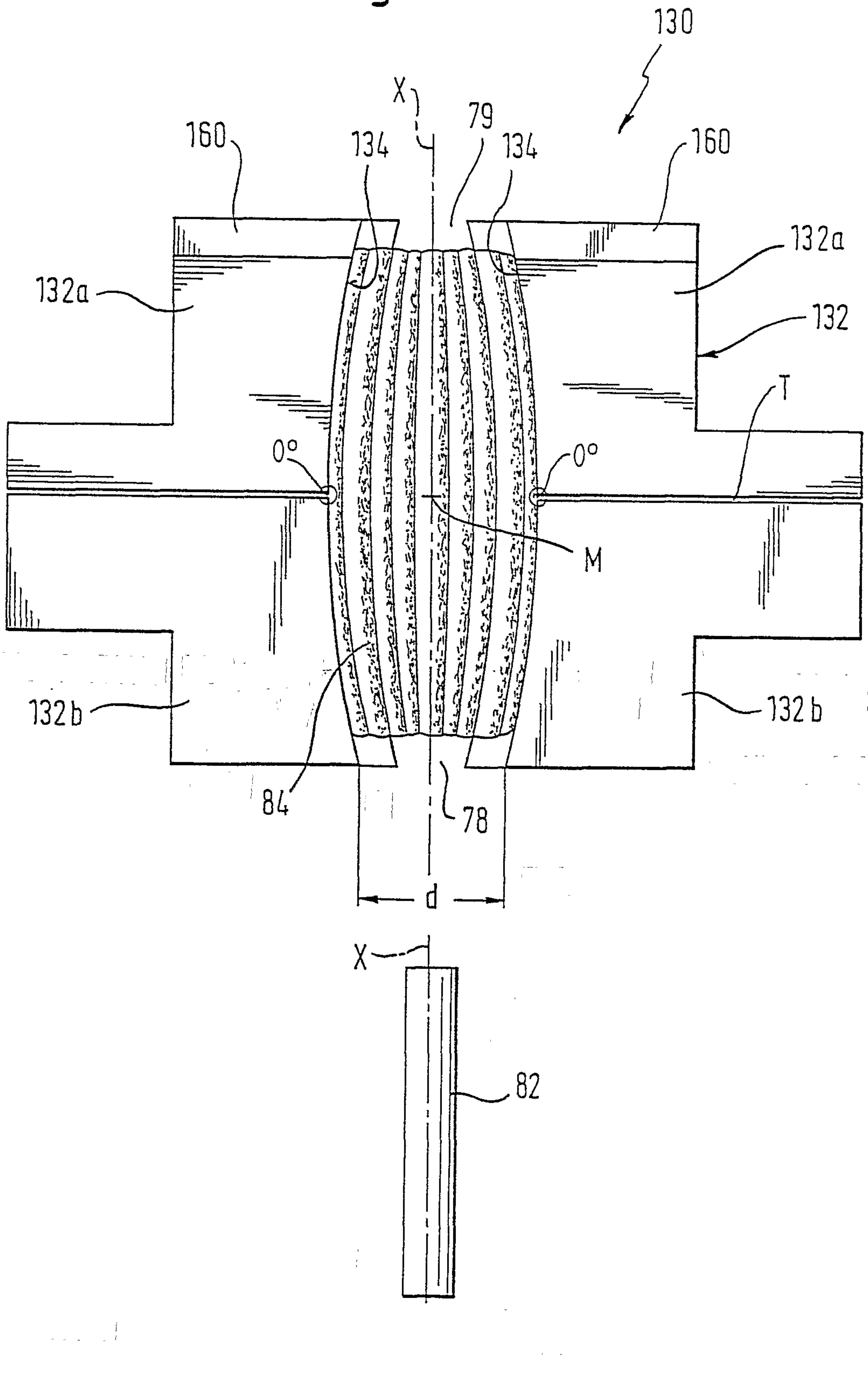


Fig. 12

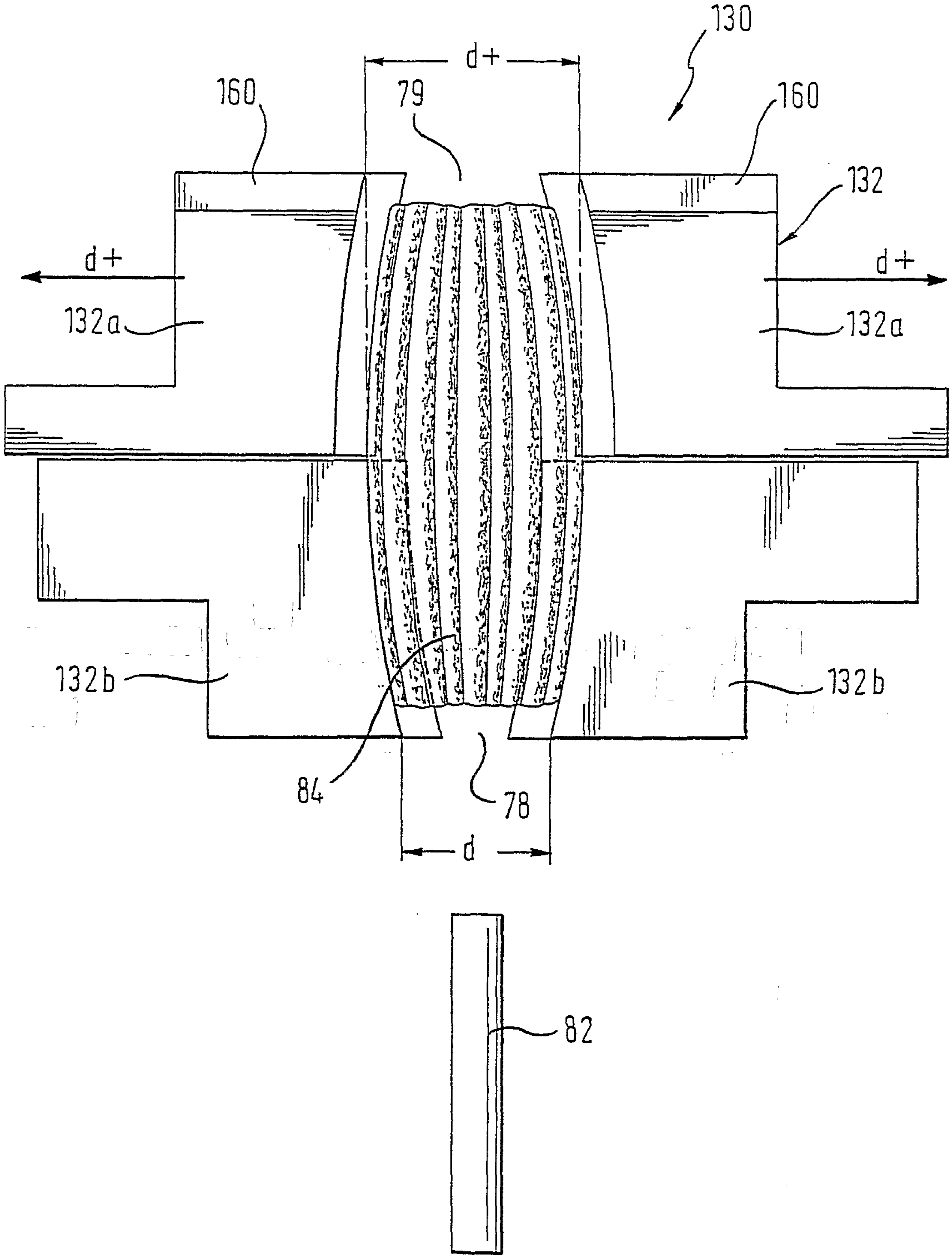
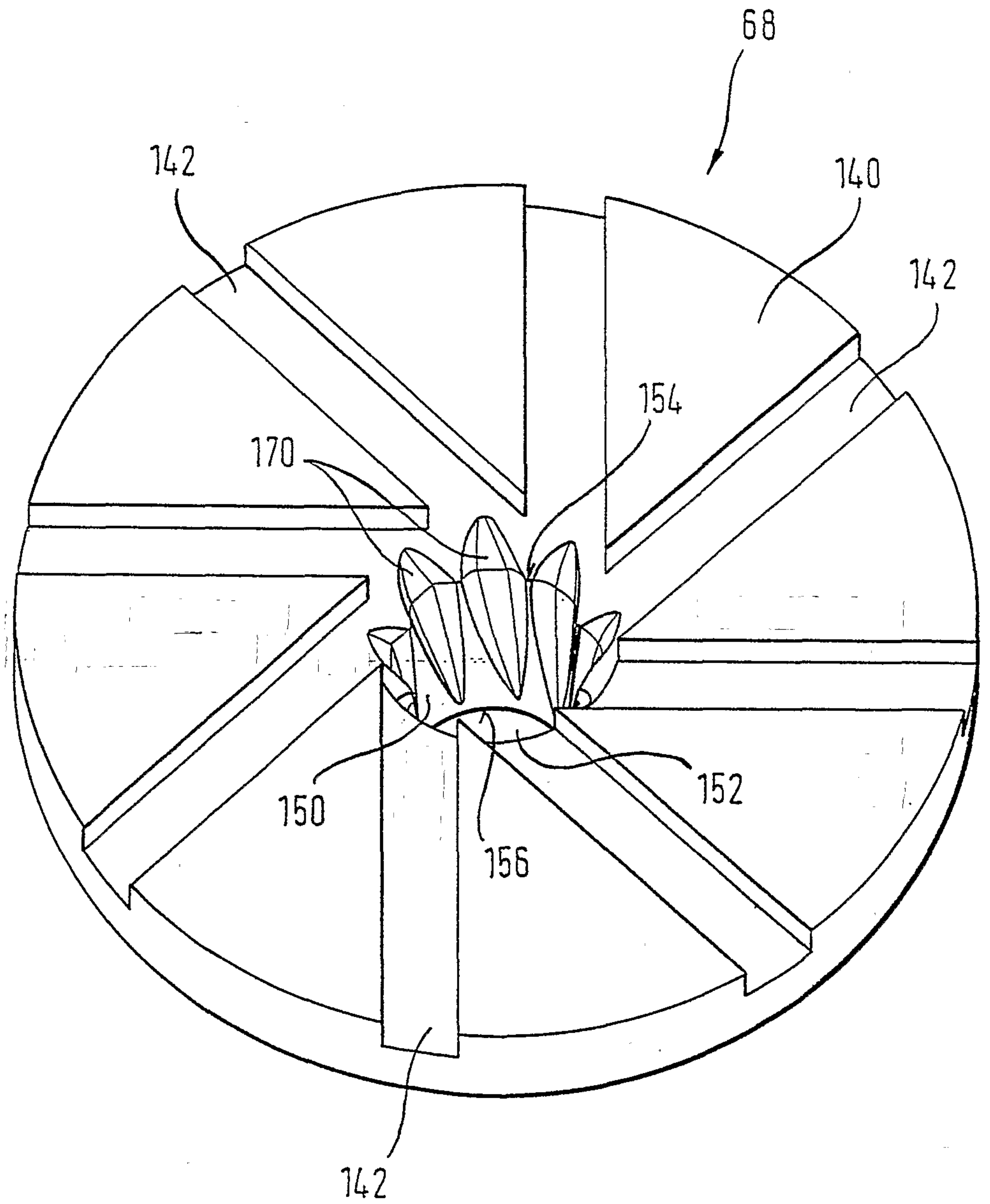


Fig. 13



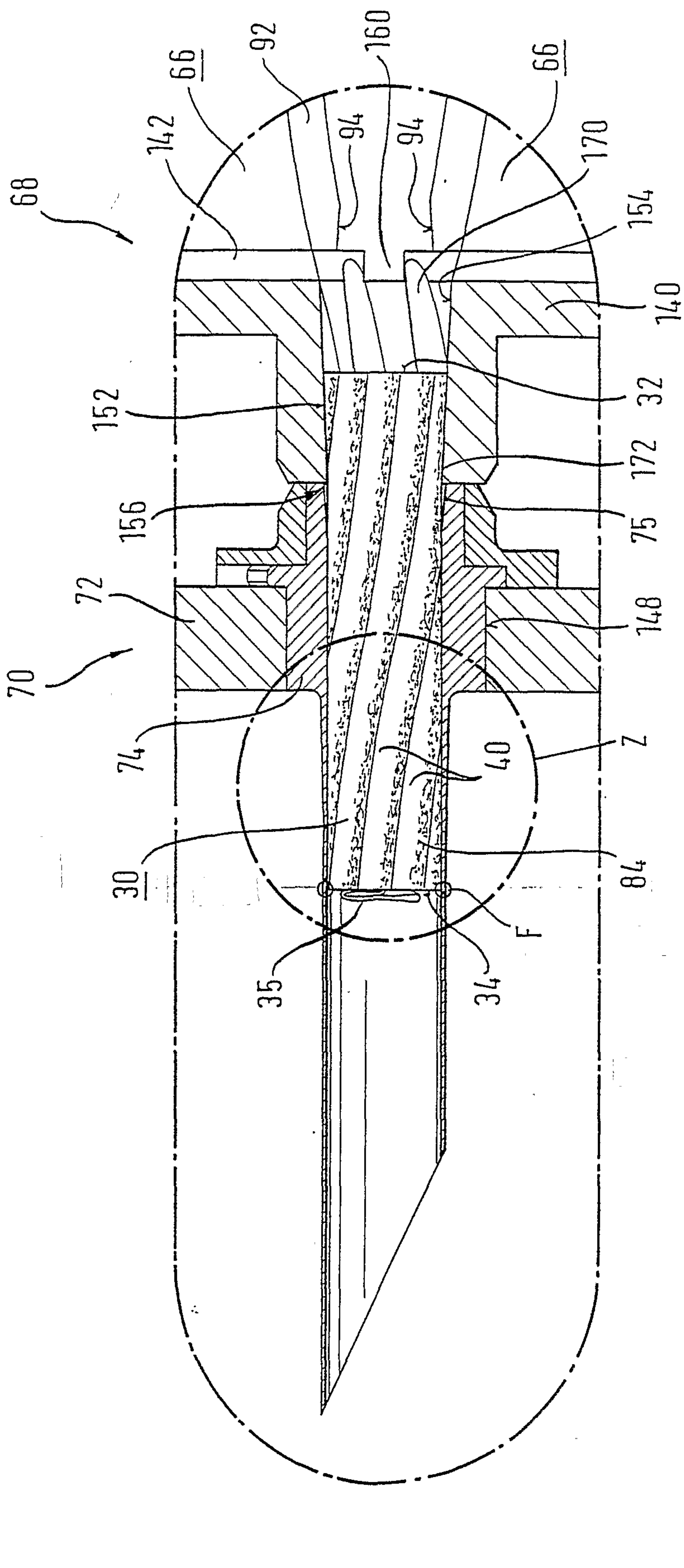

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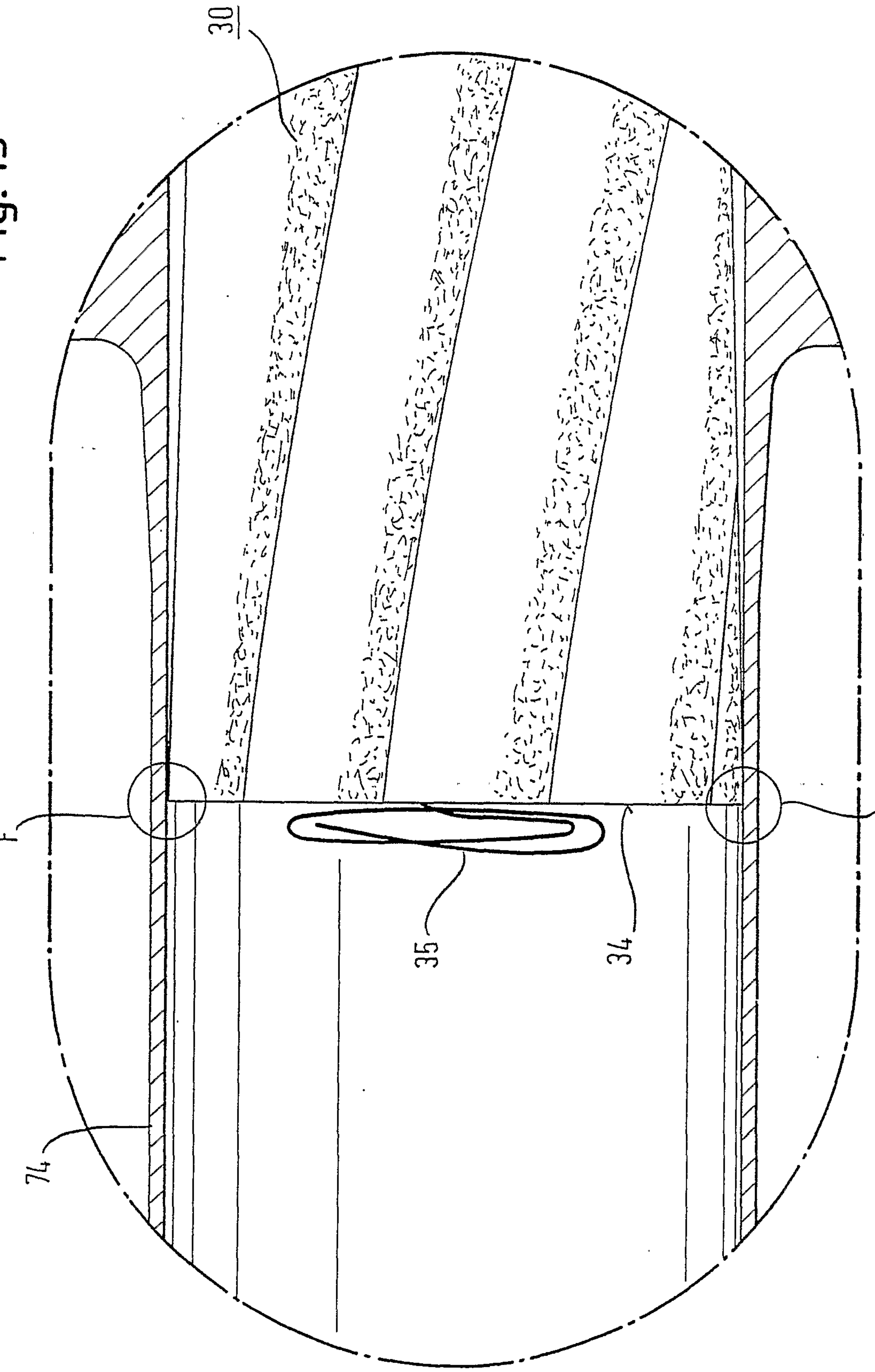
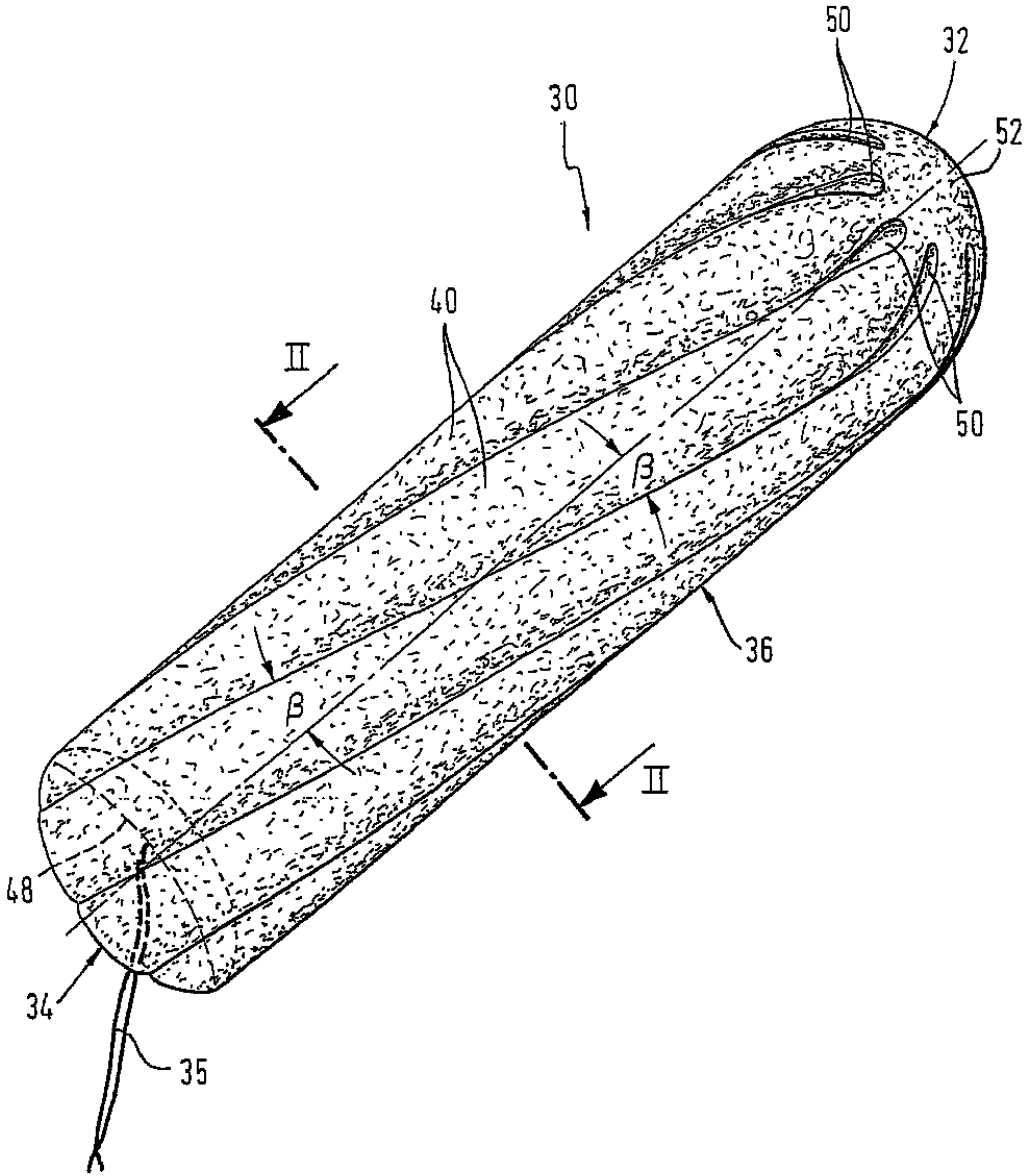
Fig. 14

Fig. 15





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β
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