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DESCRIPTION

HEAT EXCHANGER AND AIR CONDITIONING APPARATUS THEREWITH

The invention relates to a heat exchanger.

Heat exchangers for heat exchange between at least two fluids are known. For example, heat exchangers are used for heat recovery in devices for home ventilation/air conditioning. Such heat exchangers are flowed through by supply air/outside air and exhaust air, whereby, for example, the temperature of the supply air/outside air is increased in winter by the heat of the exhaust air. Known heat exchangers are in need of improvement with regard to their volume active for the degree of heat provision and/or with regard to their heat exchange surface.

From the prior art, for example, the document US 2002/0080633 A1 is known, which describes a heat exchanger according to the preamble of claim 1, while the document GB 2 439 557 A discloses a heat exchanger according to the preamble of claim 2.

The invention is therefore based on the object of providing a heat exchanger which has a volume which is particularly favourable in terms of its degree of heat provision and/or an optimally large exchange regions for the heat exchange. A particularly low sound power level is also sought. The simple connection of fluid lines and/or at least one fluid delivery device, for example a fan, is also of particular importance. A small size is also desirable.

This object is achieved in a first embodiment with a heat exchanger for heat exchange between at least two fluids in that said heat exchanger comprises a plurality of heat exchange elements, each of which has at least one fluid-guiding path for conducting at least one of the fluids through, wherein the heat exchanger has a cylindrical shape or substantially a cylindrical shape having a cylinder axis, and the heat exchange elements are arranged adjacent to each another around the cylinder axis, wherein each of the heat exchange elements or at least a region of each of the heat exchange elements forms an outline structure like or substantially like a:

- triangular cylinder or
- trapezoidal cylinder or
- circle-sector cylinder or
- annulus-sector cylinder

wherein, by means of the heat exchange elements arranged adjacent to each other, the heat exchanger or at least a region of the heat exchanger has an outline structure like a or substantially like a:

- polygonal cylinder or

- polygonal hollow cylinder or
- circular cylinder or
- annular cylinder,

and wherein each heat exchange element – as seen looking in the direction of the cylinder axis – comprises three zones, namely two cross-flow zones, between which a counterflow zone or an identical-flow zone is located, and each heat exchange element has a first heat exchange wall, which forms a common heat exchange wall for this heat exchange element and for the adjacent heat exchange element, and at least one spacer rib is arranged between adjacent first heat exchange walls, said spacer rib being a fluid-guiding rib and running obliquely to the cylinder axis and running parallel to to the cylinder axis in at least one of the counterflow zone or the identical-flow zone, wherein the heat exchanger has two front sides, which are opposite one another and have fluid openings. It is further provided that the fluid openings in the inner zone on one of the front sides are fluid inlet openings for a first fluid, and that the fluid openings in the outer zone extending around the inner zone on the other front side are fluid outlet openings for the first fluid, and that the fluid openings in the inner zone on the other front sides are fluid inlet openings for a second fluid, and that the fluid openings in the outer zone on the one front side are fluid outlet openings for the second fluid.

By designing the heat exchange elements as a triangular cylinder or trapezoidal cylinder or circle-sector cylinder or annulus-sector cylinder and arranging them adjacent to one another around the cylinder axis, so that – depending on the cylinder shape of the heat exchange elements – a polygonal cylinder or a polygonal hollow cylinder or a circular cylinder or an annular cylinder is created, an optimal heat exchange volume and an optimally large heat exchange surface is created, while still being relatively small in size. The space provided for the heat exchange or the heat exchange surface provided for the heat exchange is optimised on the basis of the geometric configuration of the heat exchange elements and of the entire heat exchanger. The degree of heat provision is optimised by the invention. If the heat exchanger has a circular cross section, the degree of heat provision is maximised. In particular, in the case of an adjacent arrangement of heat exchange elements as a triangular cylinder for the heat exchanger, the outline structure of the polygonal cylinder results. The polygonal hollow cylinder results for heat exchange elements designed as trapezoidal cylinders, wherein the polygonality is related both to the outer jacket and to the inner jacket. If circle-sector cylinders are used as heat exchange elements, the heat exchanger has an outline structure like the circular cylinder. Since the individual heat exchange elements become ever slimmer towards the centre of the cylinder of the heat exchanger and are difficult to produce there and also only develop a low efficiency for the heat exchange, it is advantageous to design the heat exchange elements as annulus-sector cylinders so that the heat exchanger is given an outline structure like the annular cylinder. This last design is particularly preferred.

The different types of cylinders of the outline structure of the heat exchanger are preferably designed as straight cylinders. Alternatively, these can also be designed as inclined cylinders. In the case of straight cylinders, this means that front sides run at right angles to the cylinder axis, one of which can also be referred to as the base side and the other as the cover side.

In the heat exchanger according to the invention, it is particularly and advantageously provided that the supply and discharge of the at least two fluids takes place at the front sides of the heat exchanger mentioned, i.e. at the front sides of the polygonal cylinder or the front sides of the polygonal hollow cylinder or the front sides of the circular cylinder or the front sides of the annular cylinder. In particular, one of the fluids is supplied to a region of one front side, then passes through the heat exchanger and is discharged to a region of the other front side. The other of the fluids is supplied to a region of the other front side, then passes through the heat exchanger and is discharged to a region of the one front side.

The heat exchange takes place between the two fluids by flowing through the heat exchanger. The two fluids are fluidically separated from one another, i.e. there is no mixing. The fluids are preferably gaseous fluids, in particular air.

This object is further achieved in a second embodiment by a heat exchanger for heat exchange between at least two fluids, comprising a plurality of heat exchange elements, each of which has at least one fluid-guiding path for conducting at least one of the fluids through, wherein the heat exchanger has a cone frustum shape or substantially a cone frustum shape having a cone frustum axis, and the heat exchange elements are arranged adjacent to each another around the cone frustum axis, wherein each of the heat exchange elements or at least a region of each of the heat exchange elements forms an outline structure like or substantially like a:

- triangular cone frustum or
- trapezoidal cone frustum or
- circle-sector cone frustum or
- annulus sector cone frustum

wherein, by means of the heat exchange elements arranged adjacent to each other, the heat exchanger or at least a region of the heat exchanger has an outline structure like a or substantially like a:

- polygonal cone frustum or
- polygonal hollow cone frustum or
- circular cone frustum or
- annular cone frustum,

and wherein each heat exchange element – as seen looking in the direction of the cone frustum axis – comprises three zones, namely two cross-flow zones, between which a counterflow zone or an identical-flow zone is located, and each heat exchange element has a first heat exchange wall, which forms a common heat exchange wall for this heat exchange element and for the adjacent heat exchange element, and at least one spacer rib is arranged between adjacent first heat exchange walls, said spacer rib being a fluid-guiding rib and running obliquely to the cone frustum axis in at least one of the cross-flow zones, and running parallel to the cone frustum axis in the counterflow zone or identical-flow zone. The embodiment given above for cylindrical heat exchangers apply accordingly. Compared to the first-mentioned, cylindrical heat exchanger, the present heat exchanger has a cone frustum shape or approximately a cone frustum of its outline structure, as seen along the cone frustum axis, so that the corresponding cone frustums mentioned above result. For the individual heat exchange elements which are arranged adjacent to one another around the cone frustum axis, the corresponding cone frustum shape results, depending on the embodiment.

A common feature of all heat exchange elements, both in the cylinder variant and in the cone frustum variant, is that they are wedge-shaped.

According to a further development of the invention, it is provided that the cylinder axis is a cylinder centre axis. In particular, the heat exchanger is constructed diametrically to the cylinder centre axis in the same way or rotationally symmetrically.

It is also advantageous if each heat exchange element has only one fluid-guiding path for the passage of only one of the fluids. In particular, it is provided that a heat exchange element adjacent to the aforementioned heat exchange element also has only one fluid-guiding path for the passage of only one of the fluids, wherein this fluid is another fluid, so that heat exchange between the fluids can take place between the two adjacent heat exchange elements.

According to the invention it is provided that each heat exchange element – viewed in the direction of the cylinder axis or the cone frustum axis – has three zones, namely two cross-flow zones, between which there is a counterflow zone or an identical-flow zone. In addition, it can be provided that the heat exchanger and/or each fluid-guiding path –

viewed in the direction of the cylinder axis or the cone frustum axis – has the three zones, namely the two cross-flow zones, between which the counterflow zone or the identical-flow zone is located. If one looks at two fluids, one of which is fed to one front side of the heat exchanger and the other to the other front side, fluid guidance occurs within the heat exchanger in such a way that a cross-flow zone is first flowed through after the entry of one fluid into the heat exchanger, i.e. there is a heat exchange with the other fluid in such a way that the two fluid flows intersect. The counterflow zone is then passed, i.e. the two fluids flow diametrically against each other in this zone. This is followed by the further cross-flow zone, in which the two fluid flows intersect, i.e. have directions that correspond to a cross. However, the fluid flows are always separated from each other by a heat exchange wall. In particular, it is provided that the counterflow zone or identical-flow zone is longer than the respective cross-flow zone, in particular the counterflow zone or identical-flow zone is three times, preferably four times, in particular greater than four times longer than the length of a cross-flow zone (in each case viewed in the direction of the cylinder axis or cone frustum axis). Instead of the counterflow zone, the above-mentioned direct current zone can also be formed, i.e. the two fluid streams flow in the same directions in this zone. This presupposes that the two fluids are fed to the same front side of the heat exchanger and are discharged from the same front side of the heat exchanger. Below, however, there are also exemplary embodiments in which the supply and/or discharge does not take place or not only on the front side or the front sides of the heat exchanger, but, if appropriate, there is a feed or discharge in the regions or additionally in the regions of an outer jacket and/or inner jacket of the heat exchanger. The above explanations apply accordingly.

A further development of the invention provides that the fluid-guiding path of the counterflow zone or the identical-flow zone runs parallel to the cylinder axis.

A further development of the invention provides that the fluid-guiding path of the counterflow zone or the identical-flow zone runs parallel or approximately parallel to the cone frustum axis.

It is also advantageous if the fluid-guiding path of at least one of the cross-flow zones runs obliquely to the cylinder axis or cone frustum axis.

According to the invention, it is provided that each heat exchange element has a first heat exchange wall which forms a common heat exchange wall for this heat exchange element and for the adjacent heat exchange element. Due to the adjacent arrangement of the heat exchange elements around the cylinder axis, the heat exchange wall is accordingly arranged between the fluid-guiding paths of the two heat exchange elements, wherein this is a common heat exchange wall.

According to one design of the invention, it is provided that each heat exchange element has a first and a second fluid-guiding path for a respective passage of one of the fluids. This means that the heat exchange element consists, as it were, of two individual elements, which are delimited relative to one another in terms of flow technology and each have a fluid-guiding path, so that the fluid-guiding paths can be flowed through by two fluids, which preferably takes place in opposite directions, at least in some regions.

According to a further development of the invention, it is provided that each heat exchange element has a second heat exchange wall which separates the first and the second fluid-guiding path in this heat exchange element from one another. This configuration is provided in particular for the heat exchange element with the two fluid-guiding paths.

A further development of the invention provides that the second heat exchange wall is designed such that it keeps the first heat exchange walls adjacent to it at a distance from one another. The second heat exchange wall thus has a dual function in that it separates the two fluids from one another and also serves as a spacer for the first heat exchange walls which adjoin them. In particular, it can be provided that the second heat exchange wall has an uneven, in particular zigzag, wave-shaped and/or meandering course, at least in sections. Due to this mentioned course of the second heat exchange wall, it can fulfil its separating function and also its function as a spacer particularly well. If the second heat exchange wall has, for example, a zigzag shape, then a first heat exchange wall can rest against the teeth on one side and a further first heat exchange wall against the teeth on the other side. This keeps the first two heat exchange walls at a distance and the cavities created by the zigzag course serve to pass the two fluids and of course to separate them in terms of flow.

According to a further development of the invention, it is provided that the first and/or the second heat exchange wall extends from an outer side/outer jacket of the heat exchanger to an inner side/an inner jacket or a centre/a cylinder axis/a cone frustum axis of the heat exchanger. The heat exchange walls therefore run from the outer side, i.e. from the outer jacket of the heat exchanger, to the inner side, for example the inner jacket of a hollow cylinder, or to the centre (in particular up to the cylinder axis/cone frustum axis) of the heat exchanger if there is no hollow cylinder/hollow cone frustum.

The invention provides that at least one spacer rib is arranged between adjacent first heat exchange walls. In addition, it can be provided that the at least one spacer rib is arranged between adjacent first and second heat exchange walls. In particular, if the first and/or second heat exchange walls consist of very thin material and/or do not have sufficient inherent rigidity, the at least one spacer has a stabilising effect on these heat exchange walls. The first and/or second heat exchange walls can allow diffusion. In such a case, such a heat exchanger can be referred to as enthalpy. If the heat exchange walls mentioned are diffusion-tight, this is referred to as a sensitive heat exchanger.

It is provided according to the invention that the at least one spacer rib is a fluid-guiding rib. It therefore has a dual function in that it on the one hand keeps the first and/or second heat exchange walls at a distance from one another and also stabilises them, and on the other hand also performs a flow control function of at least one fluid. Such a spacer rib can preferably pass through a fluid-guiding path in the longitudinal direction and holds the corresponding heat exchange walls, but at the same time divides the fluid-guiding path at least in sections into two partial regions (partial fluid flow paths along its longitudinal direction). Of course, several fluid-guiding ribs can also lie within a fluid-guiding path, so that a multi-channel flow structure is created. Such a fluid-guiding rib can also border/limit the fluid-guiding path.

A further development of the invention provides that the first and/or the second heat exchange wall is designed to be fluid-selectively permeable, in particular open to diffusion. It is preferably possible for at least one of the heat exchange walls mentioned to be permeable to water vapour, but not to air. A heat exchanger or heat exchanger as enthalpy is then also referred to. With such a configuration, moisture can be recovered. Depending on the environmental parameters, moisture can form in the heat exchanger during operation, which moisture can penetrate the first and/or second heat exchange wall and can thus be collected, for example. Alternatively, however, it is also conceivable to design the heat exchanger as a so-called sensitive heat exchanger, in which the first and/or the second heat exchange wall is designed to be diffusion-tight.

In the first embodiment of the invention and optionally in the second embodiment, it is provided that the heat exchanger has two front sides, which are opposite one another and comprise fluid openings, in particular fluid inlet and fluid outlet openings. As already mentioned at the outset, one front side forms a base side with respect to the cylindrical design of the heat exchanger and the other front side forms a cover side. Fluid inlet and fluid outlet openings are formed in/on these two sides, i.e. the two front sides, which form inlets to and outlets from the fluid-guiding paths.

A further development of the invention provides that the front sides are flat or roof-shaped running around the cylinder axis or cone frustum axis. The roof-shaped design results in a “ridge edge” that runs around the cylinder axis or cone frustum axis, in particular in a circular shape. The “ridge edge” represents the boundary between an inner zone and an outer zone, wherein fluid inlet openings and fluid outlet openings are arranged there accordingly, as explained below.

According to a further development of the invention, it is provided that the heat exchanger has an outer jacket and two front sides, which are opposite one another, and that at least one of the front sides and the outer jacket have the fluid openings, in particular fluid inlet and fluid outlet openings. As a result, the fluid openings are arranged both on the front side and on the outer jacket. It is also conceivable that the heat exchanger has an inner jacket and two front sides, which are opposite one another, and that at least one of the front sides and the inner jacket have the fluid openings, in particular fluid inlet and outlet openings.

It is also advantageous if the heat exchanger has an outer jacket and an inner jacket, and that the outer jacket and the inner jacket comprise the fluid openings, in particular fluid inlet and fluid outlet openings.

The heat exchanger can in particular be designed such that at least one of the front sides comprises an inner zone and an outer zone extending around the inner zone, wherein fluid openings in the inner zone are fluid inlet openings and fluid openings in the outer zone are fluid outlet openings and/or fluid openings in the outer zone are fluid inlet openings and fluid openings in the inner zone are fluid outlet openings.

In the first embodiment and optionally in the second embodiment, it is provided that the fluid openings in the inner zone on one of the front sides are fluid inlet openings for a first fluid, and that the fluid openings in the outer zone extending around the inner zone on the other front side are fluid outlet openings for the first fluid, and that the fluid openings in the inner zone on the other front sides are fluid inlet openings for a second fluid, and that the fluid openings in the outer zone on the one front side are fluid outlet openings for the second fluid. The two fluids accordingly flow to the different, diametrically opposite front sides of the heat exchanger, enter fluid inlet openings there, flow through the heat exchanger and flow out of fluid outlet openings which are located on the respective opposite front side. It is preferably provided that the fluid inlet openings are in the respective inner zone and the fluid outlet openings are in the respective outer zone. Each of the two fluid flows consequently enters and exits the respective outer zone, so that when one front side is viewed, the one fluid flows in the inner region and the other fluid exits from the outer region extending around it in a ring.

According to a further development of the invention, it is provided that the at least one spacer rib, in particular a fluid-guiding rib, has a catch that is larger than half the catches of the heat exchanger that extend between the front sides. Such a spacer preferably extends over at least two thirds of the catches of the heat exchanger.

According to the invention, it is provided that the at least one spacer rib, in particular the fluid-guiding rib, extends obliquely to the cylinder axis or truncated axis in at least one of the cross-flow zones. If one looks at two adjoining fluid-guiding paths, their fluid-guiding ribs in the region of the cross-flow zone each run obliquely to the cylinder axis or cone frustum axis, in opposite directions obliquely, in order to reach the cross-flows of the cross-flow zones.

Furthermore, the at least one spacer rib, in particular a fluid-guiding rib, runs in the counterflow zone or identical-flow zone parallel to the cylinder axis or cone frustum axis. If, in turn, one considers two adjoining fluid-guiding paths, the counterflow zones of these two fluid-guiding paths result in an opposite flow of the two associated fluids, in each case parallel to the cylinder axis or cone flow axis. The same applies to the identical-flow zones, but the fluids flow in the same direction.

It is advantageous if at least one ring collar is provided, which is arranged on at least one of the front sides of the heat exchanger in such a way that it fluidically separates/shields the fluid inlet openings located there from the fluid outlet openings located there. This prevents flow short-circuits, i.e. an outflowing fluid should not be able to flow back into adjacent fluid openings. This ensures a fluidic separation of the fluids.

Furthermore, the invention relates to a heat exchange element of a heat exchanger, in particular as described above, wherein the heat exchange element is wedge-shaped and has at least one fluid-guiding path running in the axial direction for the flow of a fluid, wherein the heat exchange element has wedge-shaped cross-sectional regions due to its wedge-shaped design, wherein the axial direction is at right angles or approximately at right angles to the wedge-shaped cross-sectional regions. The wedge shape can be seen by way of example from the figures of the exemplary embodiments.

The invention further relates to a heat exchanger with at least one heat exchange element, as described in the preceding paragraph, and wherein at least one further heat exchange element is provided, which is not provided in a wedge shape, but in particular with element sides running parallel to one another. The at least one first-mentioned heat exchange element thus has a wedge shape, i.e. it has a wedge-shaped cross-sectional region. The at least one further exchange element is not designed in a wedge shape, but preferably has element sides that are parallel and spaced apart. In the wedge-shaped heat exchange element, the element sides form an angle between them, in particular an acute angle. In the case of the further heat exchange element, there is no angular course between these sides, but the two sides run parallel to one another. It is clear to the person skilled in the art that from a certain number of wedge-shaped heat exchange elements and a certain number of non-wedge-shaped heat exchange elements, but for example heat exchange elements with parallel element sides, they can achieve an overall outline shape of the heat exchanger, which is particularly advantageous for a specific application. The “certain number” also includes the number “one”. The heat exchange elements with different cross-sections do not have to directly adjoin one another (although they can), for example it is possible to arrange several heat exchange elements adjacent to one another which have a wedge shape, then for example to have a non-wedge-shaped heat exchange element connected to them and then again wedge-shaped or to use at least one wedge-shaped heat exchange element. A plurality of non-wedge-shaped heat exchange elements can also lie adjacent to one another and so on.

Finally, it is advantageous if the heat exchanger has at least one fan, which is arranged within the at least one ring collar. Two fans are preferably provided, wherein each is arranged within the ring collar on the opposite front sides of the heat exchanger. The at least one fan conveys the fluid, in this case air, through the associated fluid paths of the heat exchange elements. If such a fan is also provided on the other side of the heat exchanger, it conveys the further fluid, the two fluids carrying out heat exchange to one another through the heat exchanger.

The invention further relates to an air device with a heat exchanger, as described above, and with at least one fan, preferably two fans. One fan is arranged in at least one ring collar, preferably the two fans are each arranged in a ring collar.

The drawings illustrate the invention using exemplary embodiments:

Figure 1 shows a perspective view of a heat exchanger,

Figure 2 shows the heat exchanger of Figure 1 in a cut-away view,

Figure 3 shows a plan view of a heat exchange element of the heat exchanger of Figure 1,

Figure 4 shows a perspective side view of the heat exchange element of Figure 3, and an adjacent heat exchange element, partly in a transparent representation,

Figure 5 shows a sectional view through the heat exchanger of Figure 1 and attached components or an air device,

Figure 6 shows a perspective illustration of the arrangement of Figure 5, partly in a transparent representation,

Figure 7 shows another embodiment of a heat exchanger in perspective view,

Figure 8 shows the heat exchanger of Figure 7 in a cut-away view,

Figure 9 shows a perspective view of heat exchange elements in an exploded view,

Figure 10 shows a plan view of two heat exchange elements of the heat exchanger of Figure 7,

Figure 11 shows a side view of a component of a heat exchange element,

Figure 12 shows a side view of another component of the heat exchange element,

Figure 13 shows a sectional view through the heat exchanger of Figure 7 with attached components or an air device,

Figure 14 shows a representation corresponding to Figure 13, but offset in the circumferential direction of the heat exchanger by the width of a heat exchange element,

Figure 15 shows a heat exchanger corresponding to Figure 1 according to another embodiment, but with a different inflow and outflow,

Figure 16 shows a longitudinal section through the heat exchanger according to Figure 15,

Figure 17 shows a heat exchanger according to a further exemplary embodiment corresponding to Figure 1, but again with a different inflow and outflow,

Figure 18 shows a longitudinal section through the heat exchanger of Figure 17,

Figure 19 shows a further exemplary embodiment of a heat exchanger, the central region of which is a counterflow zone or an identical-flow zone and whose end regions each formed as a cross-flow zone are roof-shaped (angular),

Figure 20 shows a longitudinal section through the heat exchanger of Figure 19.

Figure 21 shows a heat exchanger according to a further embodiment in dashed lines, the heat exchanger shown in dashed lines having a cone frustum shape and showing it in comparison to a cylindrical heat exchanger (not shown in dashed lines), and

Figure 22 shows a cross-section through two heat exchange elements of a heat exchanger.

Figure 1 shows a heat exchanger 1. The heat exchanger 1 is designed for the heat exchange between two fluids. The two fluids are preferably air.

The heat exchanger 1 has a multiplicity of heat exchange elements 2. For clarification, one of the heat exchange elements 2 in Figure 1 is provided with hatching 3. The heat exchanger 1 has a cylindrical shape 4; it has a cylinder axis 5 which passes through it in the axial direction. As can be seen from Figure 1, the heat exchange elements 2 are arranged adjacent to one another, i.e. adjacent to one another, around the cylinder axis 5, in particular along a closed circle.

In the exemplary embodiment in Figure 1, the individual heat exchange elements 2 each have the shape of a circular section cylinder 6 with regard to their outline structure (external shape). The arrangement of the heat exchange elements 2 adjacent to one another around the cylinder axis 5 results in an outline structure (external shape) for the heat exchanger 1 like an annular cylinder 7. The circular cylinder 7 of the heat exchanger 1 has two mutually opposite front sides 8, 9. Furthermore, the circular cylinder 7 has a jacket 10 which forms an outer jacket 11 and an inner jacket 13 in its hollow interior 12. The inner jacket 13 can be seen particularly well in Figure 2.

Figure 3, which shows a top view of a heat exchange element 2, shows an outer jacket element 14, an inner jacket element 15, front side elements 16 and 17 (only the front side element 16 is shown in Figure 3) and element sides 18 and 19 due to its design as a annulus-sector cylinder 6. The element sides 18 and 19 are slightly inclined towards each other, which results in the overall shape of a “piece of cake” with the tip missing. Corresponding to the radius of the outer jacket 11 and the inner jacket 13, the outer jacket elements 14 and 15 are slightly curved.

Taking the above into account, it is clear that – according to a further exemplary embodiment – a different shape of the heat exchange element 2 leads to a correspondingly different shape of the heat exchanger 1. If such a heat exchange element 2 is not designed according to Figure 3, but rather as a triangular cylinder, the outer jacket element 14 is designed in particular as a plane and the inner jacket element 15 extends to the centre of the heat exchanger, i.e. to the cylinder axis 5, and ends in a point. If such heat exchange elements 2 are arranged around the cylinder axis 5, the shape, i.e. the outline structure, of a polygonal cylinder results for the heat exchanger.

According to another exemplary embodiment, a heat exchange element 2 – again in deviation from the illustration in Figure 3 – can be designed as a trapezoidal cylinder. This means that the outer jacket element 14 and the inner jacket element 15 are each configured as a plane, with the result that the heat exchanger 1 then receives the outline structure as a polygonal hollow cylinder.

In a further exemplary embodiment, the heat exchange element 2 can be designed as a circular section cylinder, i.e. the outer jacket element 14 is designed in an arc shape and instead of the inner jacket element 15 there is a tip which extends up to the cylinder axis 5. This leads to a heat exchanger with an outline structure as a circular cylinder and thus corresponds to the illustration in Figure 1, but without a circular inner channel, i.e. without an inner jacket 13.

The following explanations regarding the internal structure of the individual heat exchange elements 2 are based on Figures 1 to 6, i.e. in the configuration of the heat exchange elements 2 as a circular section cylinder 6. However, these statements apply accordingly to the above-mentioned further exemplary embodiments of the heat exchange elements 2 as triangular cylinders or trapezoidal cylinders or circular section cylinders.

The internal structure of the heat exchange elements 2 can be seen particularly clearly from Figure 4, which shows a cut-open heat exchange element 2 in the foreground and a heat exchange element 2 behind it, for the most part in a translucent transparent representation. The heat exchange element 2 located at the background, which is essentially only transparent, is configured in the same way as the heat exchange element 2 shown in the foreground. Accordingly, the heat exchange element 2 at the rear in Figure 4 has an outer jacket element 14, an inner jacket element 15 and a plurality of radially extending radial flat ribs 21 in the same way as the one in the foreground, wherein, however, the radial flat ribs 21 of the heat transfer element 2 located in the background are slightly axially offset from the radial flat ribs 21 of the heat transfer element 2 located in the foreground, as shown in Figure 4. Inside the heat exchange element 2 in the foreground of Figure 4 there are fluid-guiding ribs 29, which will be discussed in more detail below. The fluid-guiding ribs 29 serve to guide a fluid, which flows through this heat exchange element 2, wherein this takes place in the heat exchange element 2 in the foreground from bottom right to top left or vice versa from top left to bottom right. In the heat exchange element 2 lying in the background of Figure 4, the passage of another fluid is reversed accordingly, and the respective fluid-guiding ribs 29 are thus arranged/designed such that the fluid is conducted from top right to bottom left or from bottom left to top right (each according to the direction of flow of the fluid). This different fluid exchange in the two heat exchange elements 2 mentioned is repeated in a corresponding manner in all heat exchange elements 2 of the heat exchanger 1, i.e. that heat exchange elements 2 located adjacent to one another always carry out a correspondingly different fluid exchange. In this case, there is always only one first heat exchange wall 43 between two heat exchange elements 2 located adjacent to one another, which will be discussed in more detail below. Only the heat exchange element 2 shown in the foreground of Figure 4 is explained in more detail below. This explanation then applies accordingly to all heat exchange elements 2.

According to Figure 4, said heat exchange element 2 has a plurality of radially extending radial flat ribs 21 which extend between the outer jacket element 14 and the inner jacket element 15. Figure 4 also shows a front side element 16 and a front side element 17. The front side element 16 extends from the inner jacket element in the direction of the outer jacket element 14 in such a way that there is a distance from the latter. The front side element 16 is supported by a support rib 22 which extends obliquely to the inner jacket element 15. The front side element 17 is arranged in a correspondingly reverse manner. It starts from the outer jacket element 14 and extends in the direction of the inner jacket element 15, but leaves a distance from it. Furthermore, a support rib 23 is provided for supporting the front side element 17, which extends obliquely to the outer jacket element 14. A plurality of spacer ribs 24, 25, 26, 27 and 28 are arranged within the heat exchange element 2, all of which are each designed as a fluid-guiding rib 29. By designing the spacer ribs 24 to 28 as fluid-guiding ribs 29, they have a width corresponding to the width of the heat exchange element 2 that increases over the radius, that – as Figure 3 clearly shows – in the regions of the inner jacket element 15 is not designed to be as wide as in the regions of the outer jacket element 14. The support ribs 22, 23 also form fluid-guiding ribs 29 with a width as explained above.

The spacer rib 24 runs essentially parallel to the outer jacket element 14 and thus parallel to the cylinder axis 5 (see Figures 1 and 2), wherein it begins at the level of the front side element and extends almost over the entire catches of the heat transfer element 2 and in the region of the support rib 23 takes an angled course in such a way that an inclined channel 30 is formed between the support rib 23 and the angled region 24' of the spacer rib 24. The spacer rib 25 initially runs with a region 25′ parallel to the outer jacket element 14, but its end 31 is set back, i.e. with an axial distance from the front side element 16. An angled region 25" of the spacer rib 25 runs parallel to the support rib 23 and thereby forms an inclined channel 32. An end section 33 of the spacer rib 25 in turn runs parallel to the outer jacket element 14 and ends at a radial distance and at the level of the front side element 17. The spacer rib 26 extends with an end region 34 parallel to the outer jacket element 14. This is followed by an inclined region 35 which merges into a region 26' of the spacer rib 26, wherein the latter runs parallel to the outer jacket element 14 and to corresponding regions of the spacer ribs 24 and 25. An angled end region 36 of the spacer rib 26 runs parallel to the support rib 23 and thus to the corresponding region 24', 25" of the spacer rib 24 and the spacer rib 25 and ends at an axial distance from the front side element 17. The spacer rib 27 begins at an axial distance from the front side element 16 with an obliquely extending region 37 which merges into a region 38, wherein the latter runs parallel to the outer jacket element 14 and to corresponding regions of the spacer ribs 24, 25 and 26. A subsequent region 39 of the spacer rib 27 runs obliquely in the direction of the inner jacket element 15 and then merges into an end section 40 which runs parallel and at a distance from the end section 33. The spacer rib 28 runs with an end region 41 parallel to the end region 37 and then merges into an axial section 29’, which runs parallel to the outer jacket element 14 and then merges into an obliquely running end region 42, which runs parallel and at a distance from the region 39 and maintains an axial distance from the front side element 17. When viewed from the outside in, the overall sequence is as follows: outer jacket element 14, spacer rib 24, spacer rib 25, spacer rib 26, spacer rib 27, spacer rib 28 and inner jacket element 15, wherein all the components mentioned maintain radial distances from one another, so that corresponding channels are formed between them.

It can be seen from Figure 4 that the element side 19 is formed by a first heat exchange wall 43, which extends over the entire regions in accordance with Figure 4 of the heat exchange element 2 and is shown transparently, so that the heat exchange element 2 located behind it can be viewed schematically It should also be mentioned that the front side elements 16 and 17 are fastened to corresponding radial flat ribs 21 and the spacing ribs 24 to 28, and the outer jacket element 14 and the inner jacket element 15 are held by corresponding radial flat ribs 21. The first heat exchange wall 23 is also supported on the corresponding radial flat ribs 21, but also on the ribs 24 to 28 as well as the outer jacket element 14 and the inner jacket element 15. This is particularly the case when the first heat exchange wall 43 has a corresponding flexibility. In particular, the first heat exchange wall 43 is designed as a film, which is optionally designed to be open to diffusion, in particular vapour permeable.

Since – as already mentioned – the heat exchange element 2 which follows in Figure 4, lying below and shown transparently, adjoins the heat exchange element 2 explained above with a different fluid flow pattern, the correspondingly different, transparently recognisable sloping course of the corresponding sections and regions of the associated spacer ribs 24 to 28 is present there, wherein the arrangement is preferably such that the regions of these components running parallel to the outer jacket element 14 or inner jacket element 15 are aligned with the corresponding regions of the regions of the similar components shown in the foreground of Figure 4.

Due to the distance between the front side element 16 and the outer jacket element 14, a fluid opening 44 is formed there, and due to the distance between the front side element 17 and the inner jacket element 15, a fluid opening 45 is formed there. The spacer rib 24 and the spacer rib 26 extend into the fluid opening 44. The spacer rib 25 and the spacer rib 27 extend into the fluid opening 45. It can be clearly seen from Figure 4 that the fluid opening 44 is in an outer zone 46 and that the fluid opening 45 is in an inner zone 47.

The inner zone 47 lies – viewed in the radial direction of the heat exchanger 1 – further inside and the outer zone 46 radially further outside. The arrangement is preferably such that the inner zone 47 adjoins the outer zone 46 – in the radial direction – without an overlap.

The aforementioned first heat exchange wall 43 is assigned to each heat exchange element 2. In the case of the heat exchange element 2, which can only be seen transparently from Figure 4, the associated first heat exchange wall lies at a distance from the visible heat exchange wall 43 of the heat exchange element 2 shown in the foreground. The result of this is that adjoining heat exchange elements 2 always have a common first heat exchange wall 43.

Due to the design explained above, each heat exchange element 2 is penetrated by a fluid-guiding path 48 for the passage of a fluid, in particular air, wherein the ends of the fluid-guiding path 48 are formed by the fluid openings 44 and 45 and the fluid-guiding path 48 is structured internally by the fluid spacing ribs 24 to 28, all of which form fluid-guiding ribs 29. As a result, a fluid flowing through the fluid-guiding path 48 is appropriately channelled. If it is assumed, for example, that a fluid enters the fluid opening 44, it is distributed substantially uniformly over the entire radial width of the fluid-guiding path 48 due to the corresponding inclined course of corresponding regions of the fluid-guiding ribs 29 and shortly before it exits the fluid opening 45 in turn, corresponding oblique regions of the fluid-guiding ribs 29 are deflected and can then in particular flow homogeneously out of the fluid opening 45. The correspondingly inclined sections of the fluid-guiding ribs 29 were explained above in the discussion of the spacer ribs 24 to 28. The two support ribs 22 and 23 also contribute to fluid control.

According to Figure 4, adjacent heat exchange elements 2 have fluid openings 44 and 45 at different positions. This is due to the different design of adjacent heat exchange elements 2 described above. In the heat exchange element 2 in the foreground of Figure 4, the fluid opening 44 is located on the front side 8 in the outer zone 46 and the fluid opening 45 is located on the front side 9 in the inner zone 47. In the case of the heat exchange element 2, which is shown to be largely transparent, the fluid opening 45 is located on the front side 8 in the inner zone 47 and therefore obliquely adjacent to the fluid opening 44 of the heat exchange element 2 located in the outer zone 46 in the foreground. The above arrangement describes the situation in a region of the front side 8. Accordingly, the following situation is present in a region of the front side 9: In the heat exchange element 2 in the foreground, the fluid opening 45 is – as stated – located in the inner zone 47. The fluid opening 44 of the heat exchange element 2 located behind it is

accordingly in the outer zone 46. The situation explained above occurs alternately in the adjacent heat exchange elements 2, specifically over the entire circular cylinder 7 of the heat exchanger 1 according to Figure 1.
Since, due to the explained situation of adjoining heat exchange elements 2, the diagonally running areas of the spacer ribs 24 to 28 and the diagonally running support ribs 22 and 23 point in correspondingly different directions for the adjoining heat exchange elements 2, as can also be seen in Figure 4, the respective adjacent fluid-guiding paths 48 of the heat exchange elements 2 – viewed in the direction of the longitudinal extension, i.e. in the direction of the cylinder axis 5 – result in a zonal division into three zones, namely a first cross-flow zone 49, an adjoining counterflow zone 50 and a second cross-flow zone 51, again adjoining the first.
From the above it is clear that the heat exchanger 1 according to the invention consists of individual heat exchange elements 2, which are arranged adjacent to one another to form an annular cylinder 7, wherein each are separated from one another in terms of flow technology by means of a first heat exchange wall 43, and wherein a fluid-guiding path 48 runs in each heat exchange element 2, which is divided into three zones, namely two cross-flow zones 49 and 51 with an intermediate counterflow zone 50. If two fluids are supplied on the front sides 8 and 9 in the inner zone 47, the fluid flows of adjacent heat exchange elements 2 cross in the cross-flow zones 48 and 51 and in the regions of the counterflow zones 50 the two fluids flow in opposite directions. Overall, heat exchange takes place between the two fluids through the heat exchange wall 43.
The operating situation explained above is illustrated in Figure 5, wherein one fluid is indicated by solid flow arrows and the other fluid is indicated by dashed flow arrows. The fluids are driven by means of two fans 52 and 53, which are arranged in ring collars 54 and 55, which run parallel to the cylinder axis 5 and are arranged on the front sides 8 and 9 of the heat exchanger 1 such that the outer zone 46 is fluidically separated from the inner zone 47. The outer zone 46 is delimited on both sides of the heat exchanger 1 by means of a flow tube 56, 57, preferably with a circular cross-section. The flow tubes 56 and 57 preferably run parallel to the cylinder axis 5. In Figure 5, the flow of one fluid, indicated by dashed flow arrows, can only be seen in the regions of the associated fan 53 and in the opposite outer zone 46. This results from the longitudinal section through the arrangement of Figure 5, which overall forms an air device 58. A corresponding flow would occur in a respective heat exchange element 2, which adjoins the heat exchange elements 2 shown in Figure 5, from right to left. This fluid flow enters the inner zone 47 at the front side 9 and in the outer zone 46 of the front side 8 from the heat exchanger 1

and can be recognised by the dashed arrows in Figure 5.

Figure 6 illustrates the arrangement of Figure 5 in a perspective view. It can be seen there that the ring collars 54 and 55 are held by radial ribs 59 on the flow tube 56 and 57, respectively.

Figure 7 shows a further exemplary embodiment of a heat exchanger 1. Like the heat exchanger in Figure 1, the heat exchanger in Figure 7 is designed for heat exchange between two fluids. The fluids are preferably air. The structure of the heat exchanger 1 of Figure 7 largely corresponds to the structure of the heat exchanger 1 of Figure 1, so that reference is made to Figures 1 to 6 and the associated description. However, the differences between these two embodiments are explained below.

Figure 8 shows the heat exchanger 1 of Figure 7 in a cut-away view, so that one can look inside and the individual heat exchange elements 2, which are lined up adjacent to one another over the circumference, can be seen. In the two exemplary embodiments in Figures 1 and 7, it is conceivable that the jacket 10 is composed of individual outer jacket elements 14 or is present as a coherent pipe section. The same applies to the inner jacket element 15 of these two embodiments. For both exemplary embodiments, it can further be provided that the front sides 8 and 9 are composed of individual front side elements 16 and 17, or disc-shaped, coherent front sides 8 and 9 with corresponding fluid openings 44 and 45. Nevertheless, in both exemplary embodiments, the heat exchange elements 2 can be viewed as annulus-sector cylinders 6 with regard to their outline structure and the entire heat exchanger is designed as an annular cylinder 7 with regard to the outline structure. In the exemplary embodiment in Figures 7 to 14, different types of outline structures are also conceivable for the heat exchange elements 2 and the entire heat exchanger 1, as already explained for the exemplary embodiment in Figure 1.

According to Figures 9 and 10, the structure of the heat exchange elements 2 is explained in more detail below. A sectional view of Figure 10 shows a heat exchange element 2 without the associated regions of the front sides 8 and 9. This heat exchange element 2 has two fluid-guiding paths 48 for the passage of two fluids which are in heat exchange with one another. In addition, there are adjacent heat exchange elements 2, i.e. their fluid-guiding paths 48 through which fluids flow, in heat exchange with one another.

Figure 9 shows two types of heat exchange element components 60 and 61, wherein the heat exchange element component 60 is a first heat exchange element component 60 and the heat exchange element component 61 is a second heat exchange element component 61. It can be seen in the exploded view in Figure 9 that – viewed over the circumference of the heat exchanger 1 – the heat exchange element components 60 and

61 are arranged alternately adjacent to one another. In reality, however, there is not the same distance between these heat exchange element components 60 and 61 as shown in Figure 9, but rather they are connected to one another, so that gas-tight fluid-guiding paths 48 are created. The heat exchange element components 60 and 61 are only placed next to one another or additionally connected to one another, for example by means of a welding process or another connection technique.

The heat exchange element components 60 and 61 are preferably each formed as plastic film moulded parts 62, 66, in particular as is known from blister technology. These plastic film moulded parts 62, 66 can preferably be produced in a thermoforming process. The plastic moulded parts 62, 66 are self-supporting, i.e. they have a corresponding intrinsic stability, wherein the film used is gas-tight and also diffusion-tight, so that the heat exchanger 1 produced therefrom is a sensitive heat exchanger 1 and not – like the exemplary embodiment in Figures 1 to 6 – as enthalpy.

The structure of the two heat exchange element components 60 and 61 will now be explained in more detail with reference to Figures 11 and 12, and then the assembly, in particular with regard to Figures 9 and 10.

According to Figure 11, the first heat exchange element component 60 has a plastic film moulded part 62 which is designed in one piece and has three zones, namely a first cross-flow zone 49, an adjoining counterflow zone 50 and an adjoining second cross-flow zone 51. The cross-flow zone 49 has deep-drawn spacer ribs 24, 25, 26 and 27 projecting forward from the plane 63 of the plastic film moulded part 62, i.e. from the paper plane, wherein the spacer ribs 24 to 27 each forming fluid-guiding ribs 29. When viewed from the rear of the plastic film moulded part 62, depressions corresponding to the shape of the fluid-guiding ribs 29 result. The same applies to the further deep-drawn structures worked out below from the plane 63 of the plastic film moulded part 62, as well as to the structures of the second heat exchange element component 61. Corresponding relationships are evident in the second cross-flow zone 51; spacer ribs 24 to 27 are also formed there protruding from the paper plane of Figure 11, these spacer ribs 24 to 27 likewise forming fluid-guiding ribs 29. The spacer ribs 24 to 26 in the cross-flow zones 49 and 51 have an offset course and the spacer rib 27 each has an angular course. If the corresponding spacer ribs 24 to 27 of the two sides are compared, i.e. in the first cross-flow zone 49 and the second cross-flow zone 51, they are arranged mirror-inverted in such a way that a fluid introduced horizontally in the upper left in Figure 11 is distributed over the entire width of the heat exchange element 60, flowing through the counterflow zone 50 and exiting horizontally again in the lower right area. The configuration of the counterflow zone 50 will now be discussed. This consists of a large number of deep-drawn spacer ribs 64 and 65, which run in a straight line and extend from the first cross-flow zone 49 to the second cross-flow zone 51 and run parallel to the cylinder axis 5, i.e. axially. The spacer ribs 64 and 65 alternate alternately across the width of the plastic film moulded part 62, a spacer rib 64 protruding from the paper plane to the front and a spacer rib 65 protruding from the paper plane to the rear, so that there is an overall zigzag course over the radial width of the heat exchange element component 60. According to Figure 10, it becomes clear that the height of this zigzag course increases from the inside of the heat exchanger 1 to the outside in order to achieve a corresponding circular ring-shaped cylinder contour (the dashed lines are to be taken into account).

Figure 12 shows the second heat exchange element component 61, which is designed as a plastic film moulded part 66 and has a plate-shaped plane 67. This moulded plastic film part 66 also has three zones, namely the first cross-flow zone 49, the adjoining counterflow zone 50 and the adjoining second cross-flow zone 51. A comparison of the cross-flow zones 49 and 51 of Figure 12 with the corresponding zones of Figure 11 shows that they are designed “in opposite directions” with regard to the spacing ribs 24 to 27, which also form fluid-guiding ribs 29, so that – again viewed from left to right – a fluid entering horizontally on the left side in the lower region is distributed over the entire width of the heat exchange element component 61 and flows out again horizontally on the right side in the upper region. In contrast to the first heat exchange element component 60 of Figure 11, the second heat exchange element component 61 of Figure 12 has no structure in the counterflow zone 50, but is designed in a plate-like manner according to the plane 67.

The assembly of the heat exchange element components 60 and 61 will now be explained with reference to Figure 9. It can be seen there that the end edges of the spacer ribs 65 step on the front side 68 of the adjacent heat exchange element component 61, which is shown in Figure 12. The end edges of the spacer ribs 64 (due to the perspective illustration, only one spacer rib 64 can be seen in Figure 9) come against the rear side 69 of the heat exchange element component 61 adjacent there during assembly. Accordingly, the end edges of the spacer ribs 24 to 27 in the two cross-flow zones 49 and 51 of the first heat exchange element component 60 likewise step against the rear side 69 of the second heat exchange element component 61. The end edges of the spacer ribs 24 to 27 of the second heat exchange element component 61 come against the rear side 70 of the first heat exchange element component 60. This situation, described above, is present in all the heat exchange element components 60 and 61 lined up in a row and leads to a heat exchanger 1, as is explained below in particular with reference to Figures 13 and 14.

With regard to Figure 10, however, it should also be noted that due to the zigzag design of the first heat exchange element component 60, a fluid-guiding path 48 is configured on both sides of the plane 63, that is, such a circular section cylinder 6 as shown in Figure 10, that is, such a heat exchange element 2 has two fluid-guiding paths 48. The respective limitation of the outline structure of this heat exchange element 2, which is shown in Figure 10, is indicated by a dashed line and – according to the above explanations – is formed by opposite regions of the adjacent heat exchange element components 61. These regions are “common regions”. The heat exchange element 2 of Figure 10 is therefore formed by the heat exchange element component 60 and the heat exchange element component 61 indicated by the double dashed line.

The following situation arises, with Figures 13 and 14 – just like in Figures 5 and 6 – showing an air device 58, i.e. the heat exchanger 1 with further, attached components, namely the fans 52 and 53, the ring collars 54 and 55 and the flow tubes 56 and 57, wherein the latter may also be formed by a continuous tube.

Figure 13 illustrates with solid arrows the (from left to right) flow of a first fluid which is driven by the fan 52, wherein the latter supplies the first fluid to the inner zone 47 of the heat exchanger 1. The first fluid entering the corresponding fluid opening 45 is distributed in the first cross-flow zone 49 due to the correspondingly designed fluid webs 29 and thereby reaches the counter-flow zone 58 and from there the flow of the first fluid in the second cross-flow zone 51 is directed with a radial component outwards through the fluid opening 44 into the outer zone 46 and thus exits the annular space between the ring collar 55 and the flow tube 57. Figure 14 explains with dashed arrows the flow (from right to left) of a second fluid, which is fed to the heat exchanger 1 by means of the fan 53, namely the respective fluid opening 45 in the inner zone 47. Correspondingly, the same flow conditions result as described in Figure 13, i.e. the second fluid passes through the counterflow region 50 and is then directed outward in the cross-flow region 49 and therefore reaches the outer zone 46 through the fluid opening 44. Since the individual fluid-guiding paths 48 formed in this way are separated from one another over the circumference of the heat exchanger 1, heat exchange takes place through the material of the heat exchange element components 60, 61, i.e. the two fluids mentioned undergo heat exchange.

In the heat exchange element 2 of the exemplary embodiment in Figures 7 to 14, the heat exchange element component 61 represents a first heat exchange wall 43, which enables heat exchange to an adjacent heat exchange element 2. The heat exchange element component 60 of the heat exchange element 2 represents a second heat exchange wall 71, which separates the first and the second fluid-guiding path 48 in this heat exchange element 2 from one another.

The above statements and also the exemplary embodiments described below illustrate that the individual heat exchange element 2 is wedge-shaped. It has at least one fluid-guiding path 48 in the axial direction for flowing through a fluid, wherein the heat exchange element 2 has a wedge-shaped cross-sectional region due to its wedge-shaped design,wherein the axial direction, namely the cylinder axis 5 mentioned above or the cone frustum axis mentioned below is rectangular or approximately runs at right angles to the wedge-shaped cross-sectional region.

Figure 15 shows a further exemplary embodiment of a heat exchanger 1. This exemplary embodiment differs from the exemplary embodiment in Figure 1 in particular in that the fluid openings 44 and 45 are located elsewhere. If one looks at one of the many heat exchange elements 2 strung together, it becomes clear that a fluid opening 43 lies on the outer jacket 11 and the associated fluid opening 45 on the front side 8. Corresponding conditions exist in the adjacent heat exchange element 2, namely the fluid opening 44 is also located on the outer jacket 11, but in the opposite edge region with respect to the aforementioned fluid opening 44 of the adjacent heat exchange element 2 and the associated fluid opening 45 is located on the front side 9. The conditions are particularly clear from Figure 16, which shows a longitudinal section. The central region of the heat exchanger of Figure 15 is designed similarly or exactly as the corresponding regions of the embodiment of Figure 1. The course of the flow of a fluid is shown in Figure 16 by means of arrows 72. Of course, according to a further exemplary embodiment, a corresponding embodiment according to Figures 15 and 16 can also be present if there is no circular cylinder, but rather a circular cylinder, a polygonal cylinder or a polygonal hollow cylinder for the outline structure of the entire heat exchanger 1.

Figures 17 and 18 correspond to Figures 15 and 16, but again the position of the inflow and outflow for the fluids is configured differently, namely in such a way that fluid openings 44 lie on the outer jacket 11 and fluid openings 45 on the inner jacket 13, so that the flow course for a fluid according to arrow 73 results (see in particular Figure 18). Otherwise, reference is made to the above statements relating to Figures 15 and 16 and Figure 1.

The embodiment of Figure 19 essentially corresponds to the embodiment of Figure 1, but only the counterflow zone 50 is cylindrical. Instead of the counterflow zone 50, there can also be an identical-flow zone. The two cross-current zones 49 and 51 are roof-shaped, running around the cylinder axis 5. As a result, there are no flat front sides, but rather sides 74 and 75 which are roof-shaped (at an angle) and which are provided with corresponding fluid openings 44 and 45. The flow profile of one of the wedge-shaped heat exchange elements 2 can be seen in Figure 20 in accordance with the arrows 76 shown there. Otherwise, the explanations for the exemplary embodiments in Figures 1, 15 to 18 apply correspondingly to the exemplary embodiment in Figures 19 and 20.

Figure 21 shows a further exemplary embodiment of a heat exchanger 1, the outline structure of which is designed like or essentially like a cone frustum 77. The cone frustum 77 has a cone frustum axis 78. Figure 21 illustrates only the outline structure in dashed lines in comparison to the outline structure of the heat exchanger 1 of Figure 1, shown with solid lines. However, the person skilled in the art immediately knows how the heat exchange elements 2 and – according to the various exemplary embodiments above – the position of the fluid openings 44 and 45 must be designed. Of course, in the cone frustum shape of Figure 21, the centre may not be hollow, but may extend up to the cone frustum axis 78. Furthermore, the inside 12, i.e. the hollow regions, can be cylindrical or also cone-shaped, i.e. conical.

Figure 22 shows a section through a heat exchanger 1 which has a wedge-shaped heat exchange element 2 to which a non-wedge-shaped heat exchange element 2 is adjacent. In the case of the wedge-shaped heat exchange element 2, the element sides 18 and 19 run at an angle to one another. In the adjacent, non-wedge-shaped heat exchange element 2, the element sides 18 and 19 thereof run parallel to one another, for example. A desired heat exchanger 1 can thus be realised by an appropriate choice, arrangement and number of appropriately equipped heat exchange elements 2.

VARMEVEKSLER OG TILHØRENDE LUFTTEKNISK ENHED

PATENTKRAV

1. Varmeveksler (1) til varmeoverførsel mellem mindst to fluider, med flere varmeoverførselselementer (2), der hver har mindst en fluidføringsbane (48), hvor mindst en af fluiderne kan passere, hvor varmeveksleren (1) har en eller i det væsentlige en cylindrisk form med en cylinderakse (5), og hvor varmeoverførselselementerne (2) er placeret ved siden af hinanden omkring cylinderaksen (5), hvor hvert af varmeoverførselselementerne (2) eller respektivt i det mindste en del af dem har en konturmæssig struktur, som en eller som i det væsentlige en:
- trekantet cylinder eller
- trapezformet cylinder eller
- cirkeludsnit-cylinder eller
- cirkelringsudsnit-cylinder (6),
hvor varmeveksleren (1) eller i det mindste et område af denne takket være de tilstødende anbragte varmeoverførselselementer (2), har en konturmæssig struktur som en eller som i det væsentlige en:
- polygonal cylinder eller
- polygonal hul cylinder eller
- cirkulær cylinder eller
- ringformet cylinder (7),
og hvor
hvert varmeoverførselssselement (2) - set i cylinderaksens (5) retning - har tre zoner, nemlig to tværstrømszoner (49, 51), mellem hvilke der er en modstrømszone (50) eller en medstrømszone, og hvert varmeoverførselselement (2) har en første varmeoverførselsvæg (43), der danner en fælles varmeoverførselsvæg (43) til dette varmeoverførselselement (2) og til det tilstødende varmeoverførselselement (2), og hvor der er anbragt mindst en afstandsbane (24, 25, 26, 27, 28) mellem de tilstødende, første varmeoverførselsvægge (43), som er en fluidføringsbane (29), og som forløber i mindst en af tværstrømningszonerne (49, 51), skråt i forhold til cylinderaksen (5), og i modstrømszonen (50) eller medstrømszonen, parallelt med cylinderaksen (5), hvor varmeveksleren (1) har to modstående endeflader (8, 9), som har fluidåbninger (44, 45), **kendetegnet ved, at**

fluidåbningerne (44, 45) ved en af endefladerne (8,9) er i en indre zone (47) af fluidindløbsåbninger for en første fluid, og at fluidåbningerne (44, 45) ved den anden endeflade (9, 8) i den ydre zone (46), der strækker sig omkring den indre zone (47), er fluidudløbsåbninger for for den første fluid, og at fluidåbningerne (44, 45) ved den anden endeflade (9,8) i den indre zone (47) er fluidindløbsåbninger for en anden fluid, og at fluidåbningerne (44, 45) ved den ene endeflade (8, 9) i den ydre zone (46) er fluidudløbsåbninger for den anden fluid.

2. Varmeveksler (1) til varmeveksling mellem mindst to fluider med flere varmeoverførselselementer (2), der hver har mindst en fluidføringsbane (48), hvor mindst en af fluiderne kan passere, hvor varmeveksleren (1) har en eller i det væsentlige en keglestubform med en keglestubformet akse, og varmeoverførselselementerne (2) er placeret ved siden af hinanden omkring cylinderaksen, hvor hvert af varmeoverførselselementerne (2) eller i det mindste et område af disse har en konturmæssig struktur som en eller i det væsentlige som en:

- trekantet keglestub eller
- trapezformet keglestub eller
- cirkeludsnit-keglestub eller
- cirkelringsudsnit-kegleskub,

hvor varmeveksleren (1) eller i det mindste et område af denne takket være de tilstødende anbragte varmeoverførselselementer (2), har en konturmæssig struktur som en eller som i det væsentlige en:

- polygonal keglestub eller
- polygonal, hul keglestub eller
- cirkulær keglestub eller
- cirkelrings-keglestub,

og hvor

hvert varmeoverførselselement (2) - set i retning af keglestubbens akse - har tre zoner, nemlig to tværstrømningszoner (49, 51), mellem hvilke der er en modstrømszone (50) eller en medstrømszone, og hvert varmeoverførselselement (2), har en første varmeoverførselsvæg (43) der danner en fælles varmeoverførselsvæg (43) for dette varmeoverførselselement (2) og for det tilstødende varmeoverførselselement (2), **kendetegnet ved, at** der mellem tilstødende første varmeoverførselsvægge (43) er anbragt mindst en afstandsbane (24, 25, 26, 27, 28), der er en fludføringsane (29), og som forløber parallelt med keglestubaksen i mindst en af tværstrømningszonerne (49, 51) skråt i forhold til keglestubbens akse og i modstrømszonen (50) eller medstrømszonen.

3. Varmeveksler ifølge et af de foregående krav, **kendetegnet ved, at** fluidføringsbanen (48) i modstrømszonen (50) eller medstrømszonen løber parallelt med cylinderaksen (5).

4. Varmeveksler ifølge et af de foregående krav, **kendetegnet ved, at** fluidføringsbanen i modstrømszonen eller medstrømszonen løber parallelt eller næsten parallelt med keglestubbens akse.

5. Varmeveksler ifølge et af de foregående krav, **kendetegnet ved at** fluidføringsbanen (48) fra mindst en af tværstrømningszonerne (49, 51) løber skråt i forhold til cylinderaksen (5) eller keglestubbens akse.

6. Varmeveksler ifølge et af de foregående krav, **kendetegnet ved, at** hvert varmeoverførselselement (2) har en første og en anden fluidføringsbane (48) til en respektiv passage af en af fluiderne.

7. Varmeveksler ifølge et af de foregående krav, **kendetegnet ved, at** hvert varmeoverførselselement (2) har en anden varmeoverførselsvæg (71), der adskiller den første og den anden fluidføringsbane (48) fra hinanden i dette varmeoverførselselement (2).

8. Varmeveksler ifølge krav 7, **kendetegnet ved, at** den anden varmeoverførselsvæg (71) er udformet således, at den holder første tilstødende varmeoverførselsvægge (43) i en vis afstand fra hinanden.

9. Varmeveksler ifølge krav 7 eller 8, **kendetegnet ved, at** den første og/eller den anden varmeoverførselsvæg (43, 71) strækker sig fra en yderside/udvendig kappe (11) på varmeveksleren (1) til en inderside/indvendig kappe (13) eller et center/cylinderakse (5)/keglestubakse i varmeveksleren (1).

10. Varmeveksler ifølge et af de foregående krav, **kendetegnet ved, at** varmeveksleren (1) har to modstående endeflader (8, 9), som har fluidåbninger (44, 45), navnlig fluidindløbs- og fluidudløbsåbninger.

11. Varmeveksler ifølge et af de foregående krav, **kendetegnet ved, at** varmeveksleren (1) har en udvendig kappe (11) og to modstående endeflader (8, 9), og at mindst en af endefladerne (8, 9) og den udvendige kappe (11) har fluidåbninger (44, 45), navnlig fluidindløbs- og fluidudløbsåbninger.

12. Varmeveksler ifølge et af de foregående krav, **kendetegnet ved, at** varmeveksleren (1) har en udvendig kappe (11) og en indvendig kappe (13), og at den udvendige kappe (11) og den indvendige kappe (13) har fluidåbninger (44, 45), navnlig har fluidindløbs- og fluidudløbsåbninger.

13. Varmeveksler ifølge et af de foregående krav, **kendetegnet ved, at** mindst en af endefladerne (8, 9) har en indre zone (47) og en ydre zone (46), der strækker sig omkring den indre zone (47), hvor fluidåbninger (44, 45) i den indre zone (47) er fluidindløbsåbninger og fluidåbninger (44, 45) i den ydre zone (46) er fluidudløbsåbninger, eller hvor fluidåbninger (44, 45) i den ydre zone (46) er fluidindløbsåbninger, og fluidåbninger (44, 45) i den indre zone (47) er fluidudløbsåbninger.

14. Varmeveksler ifølge et af de foregående krav, **kendetegnet ved, at** ved en af endefladerne (8, 9) er fluidåbningerne (44, 45) i den indre zone (47) fluidindløbsåbninger for en første fluid, og at ved den anden endeflade (9,8) fluidåbningerne (44, 45) i den ydre zone (46) er fluidudløbsåbninger for den første fluid, og at ved den anden endeflade (9, 8) fluidåbningerne (44, 45) i den indre zone (47) er fluidindløbsåbninger for en anden fluid, og at ved den ene endeside (8,9) fluidåbningerne (44, 45) i den ydre zone (46) er fluidudløbsåbninger for den anden fluid.

15. Luftteknisk indretning (58) med en varmeveksler (1) ifølge. et af de foregående krav, **kendetegnet ved** mindst en ringkrave (54, 55), som er placeret ved mindst en af endefladerne (8, 9) på varmeveksleren (1), således at den på en strømteknisk måde adskiller de væskeindløbsåbninger, der er placeret dér, fra væskeudløbsåbningerne, der er placeret

dér, og via mindst en ventilator (52, 53), der er placeret inden i den mindst ene ringkrave (54, 55).

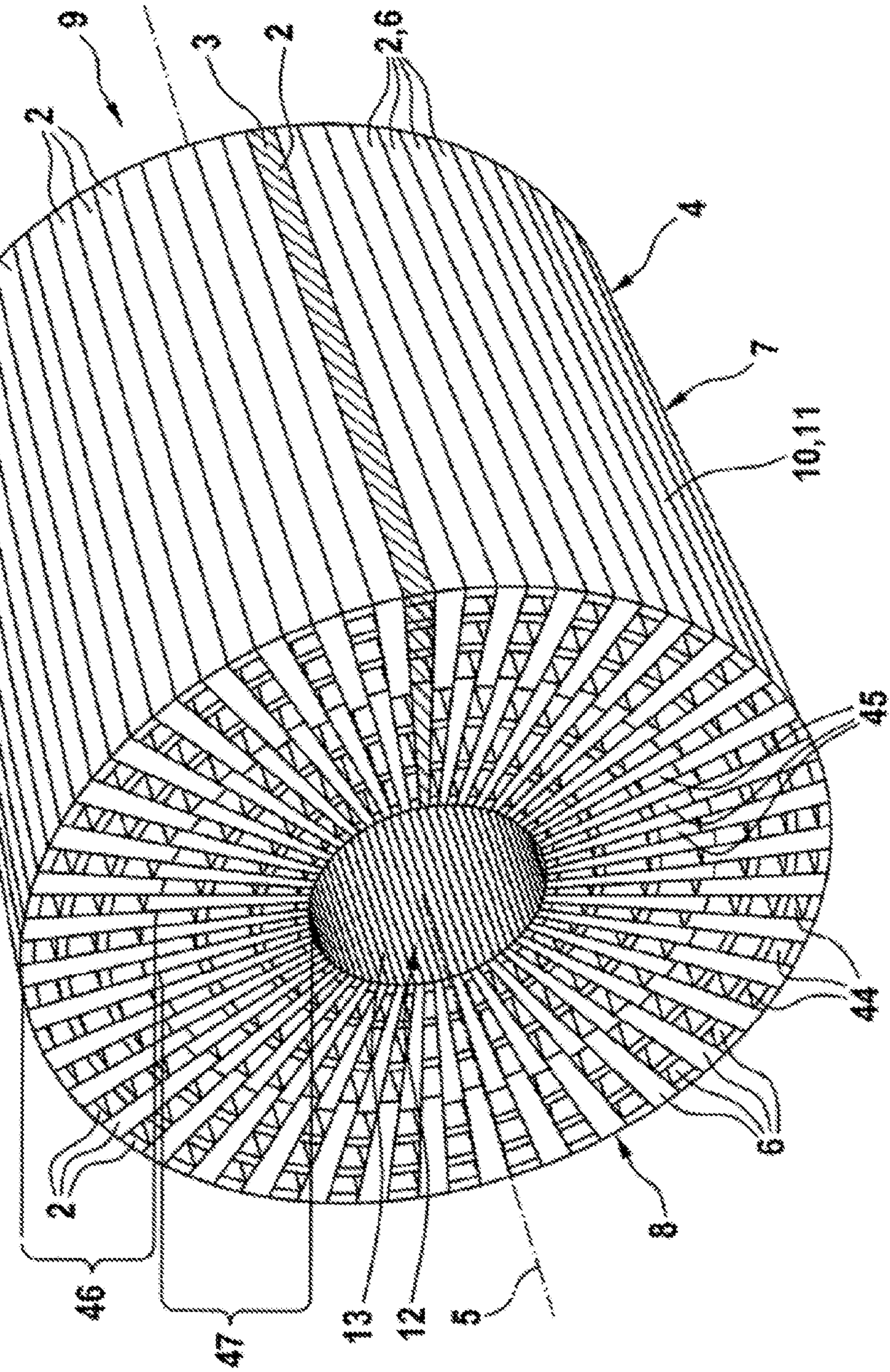


Fig. 1

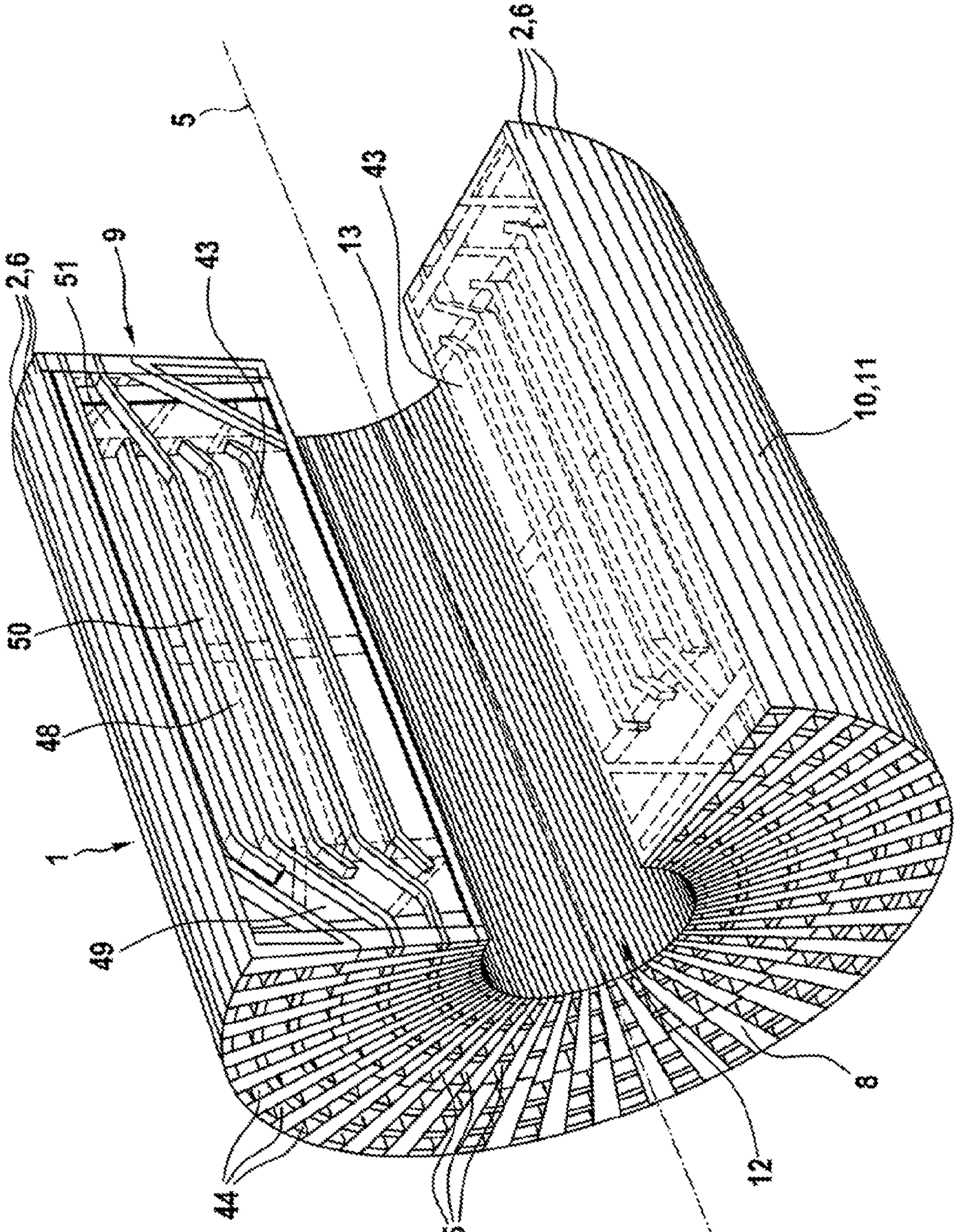
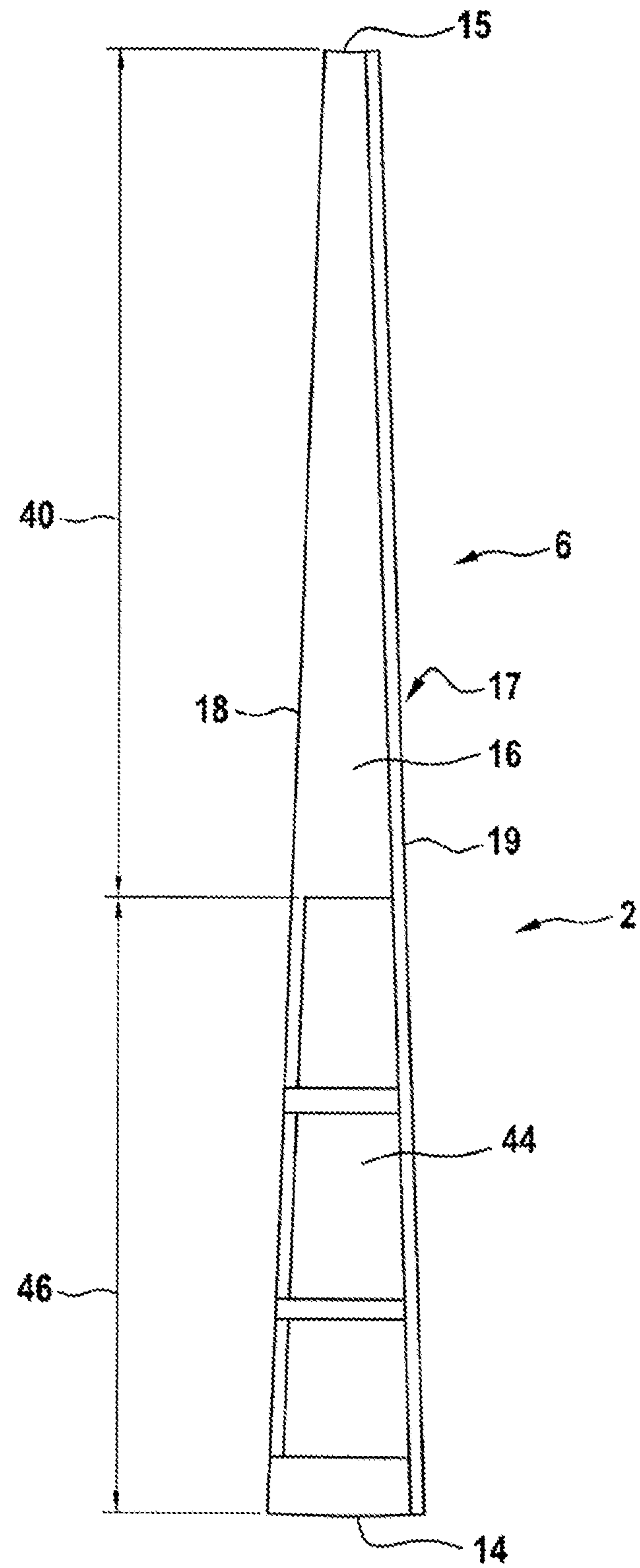


Fig. 2

Fig. 3



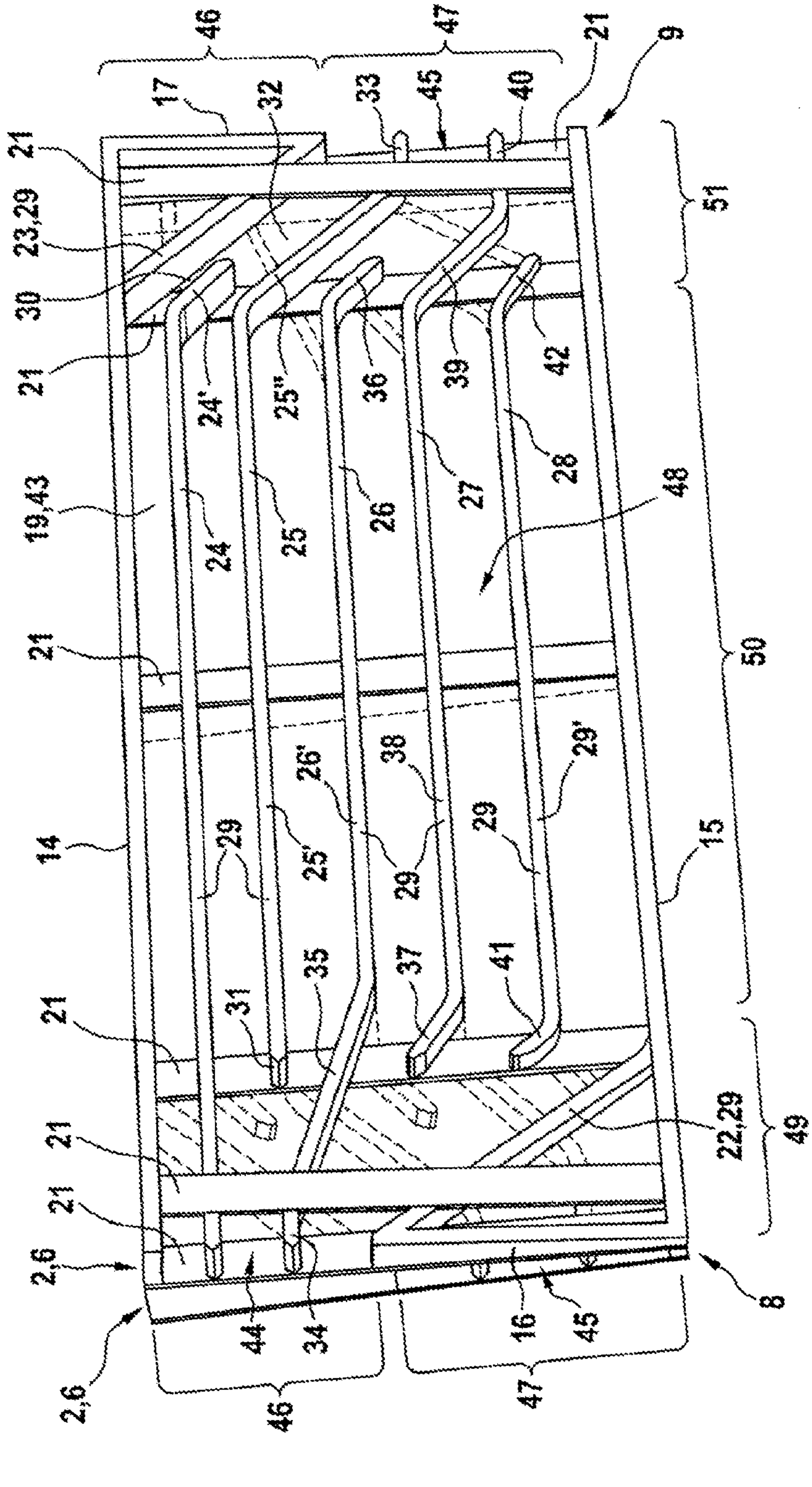

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Fig. 4

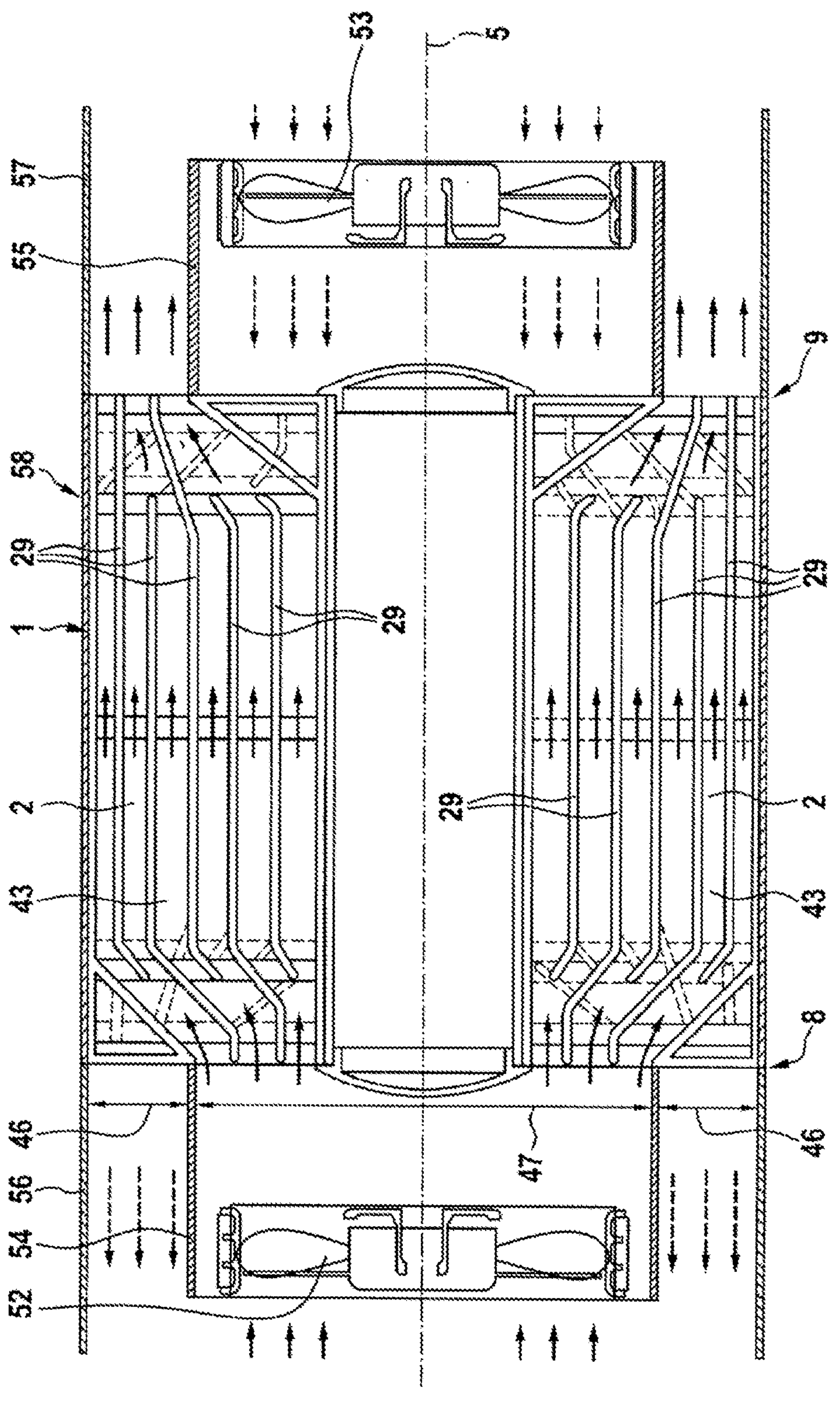
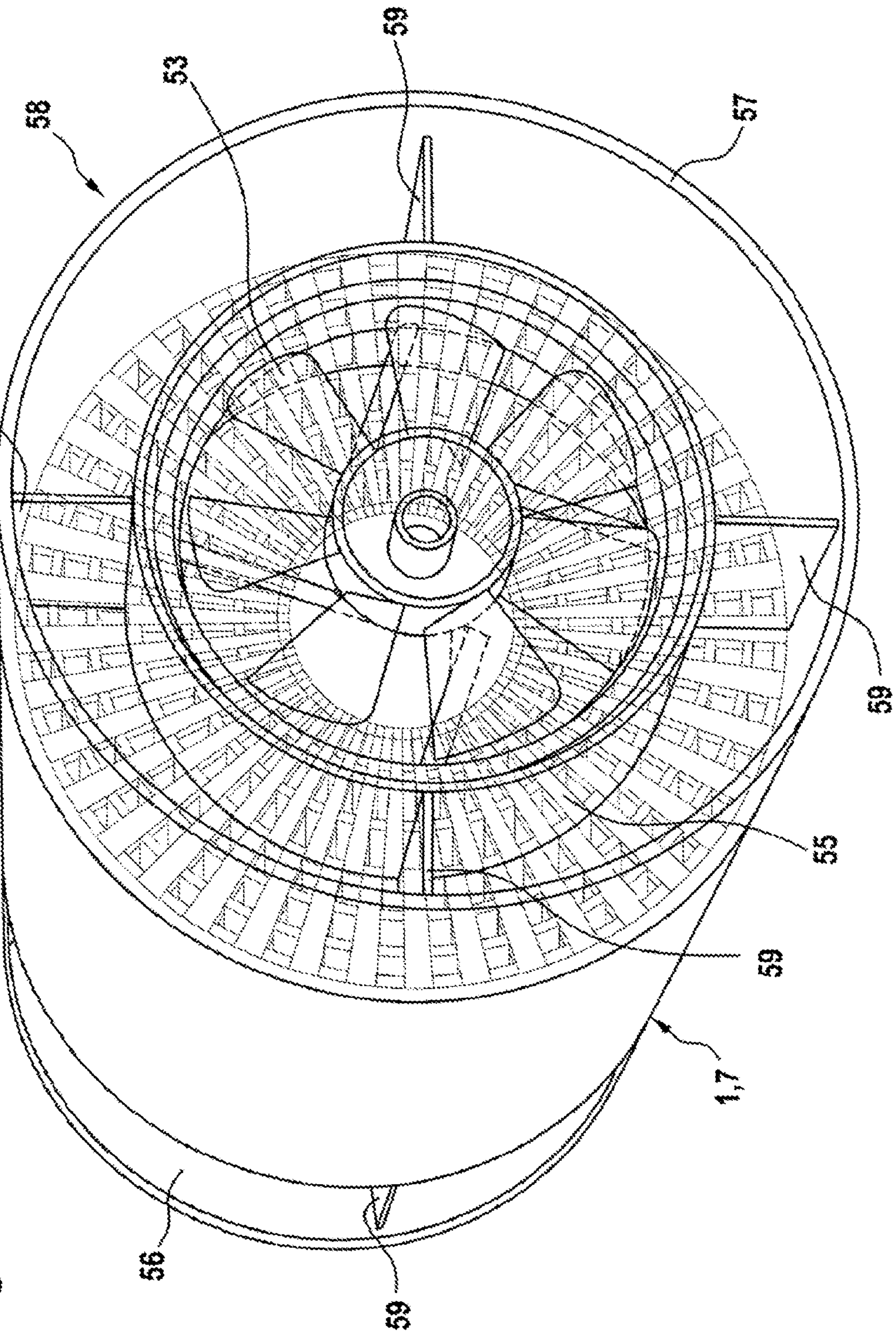
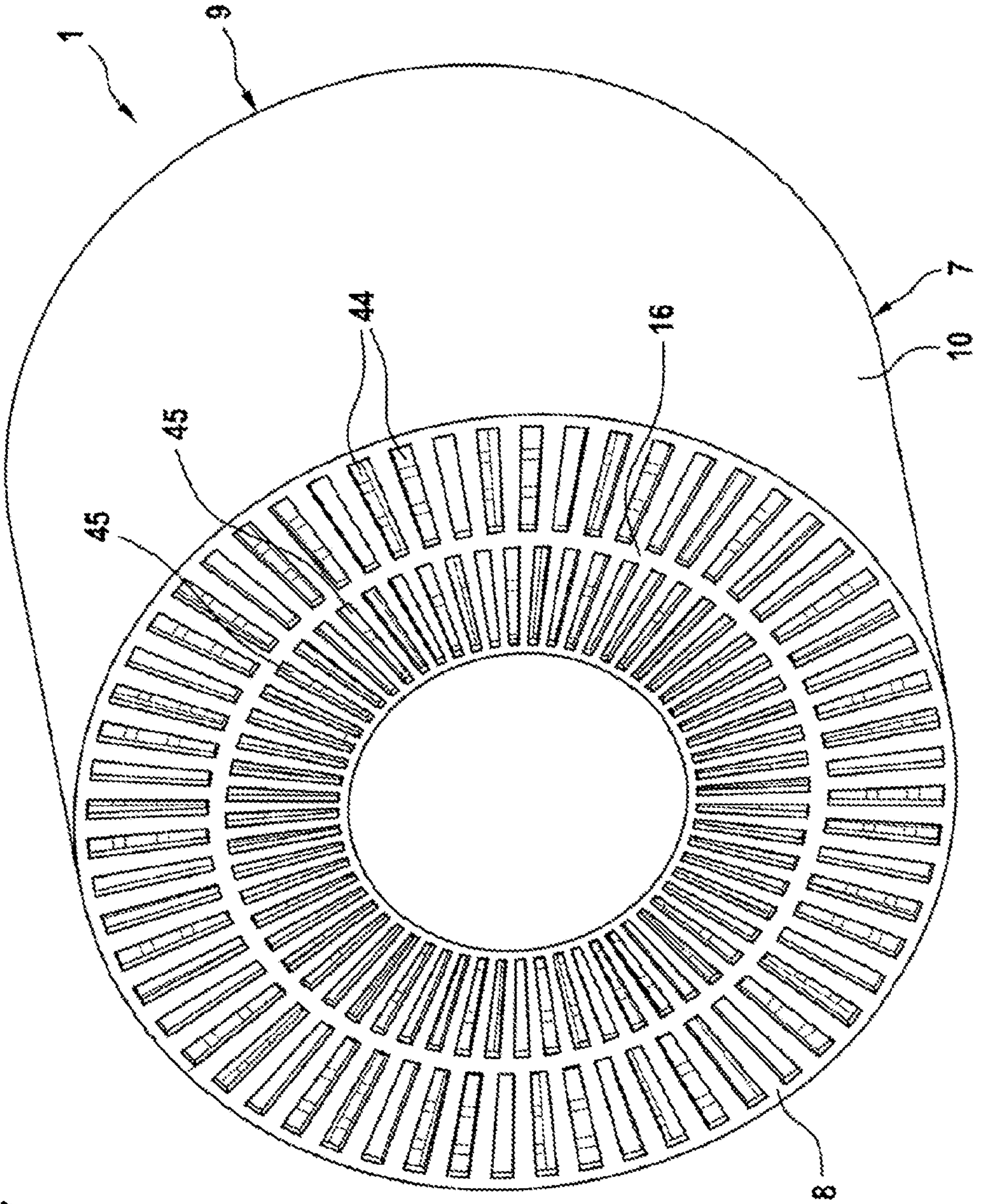


Fig. 5

Fig. 6





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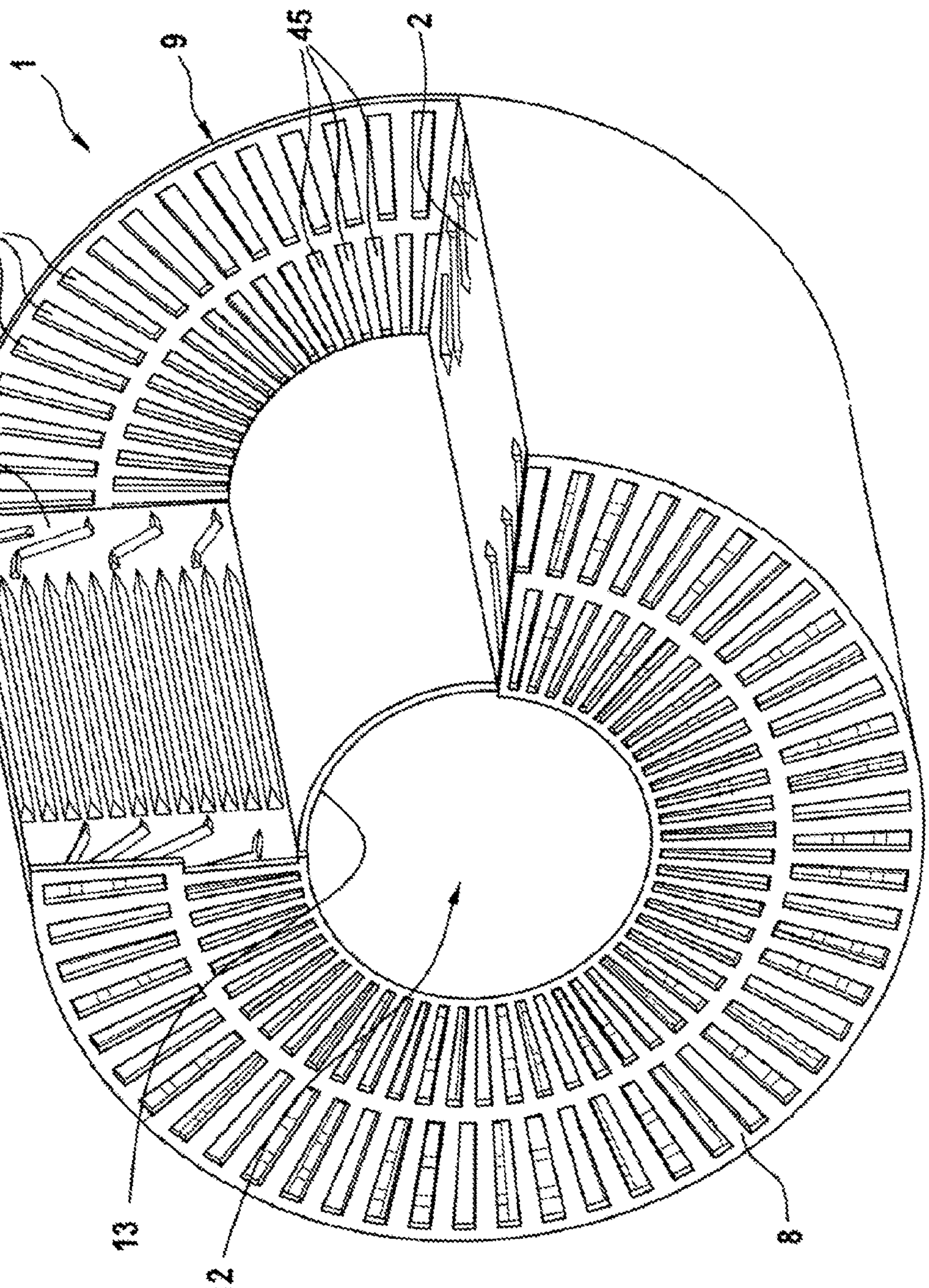


Fig. 8

Fig. 9

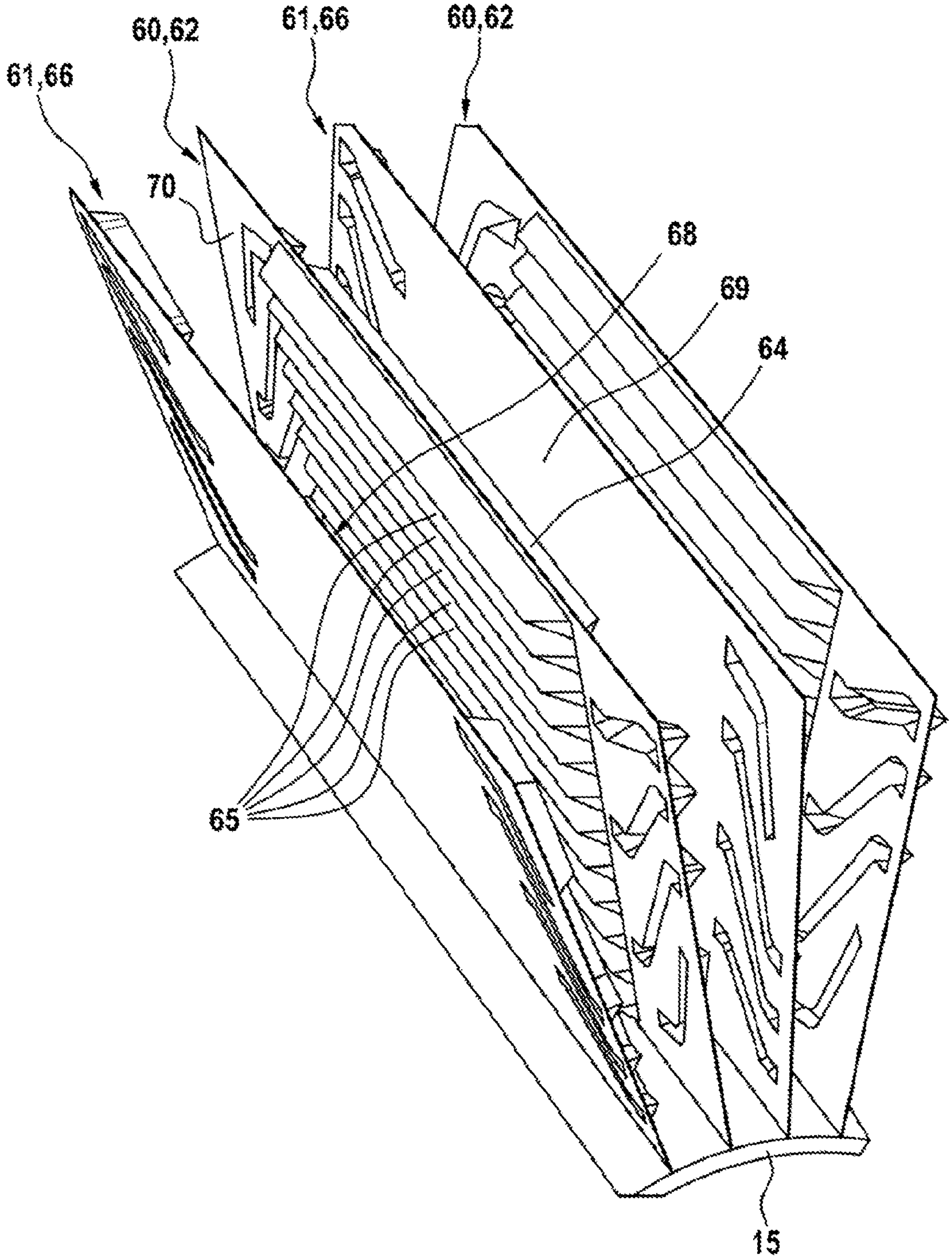
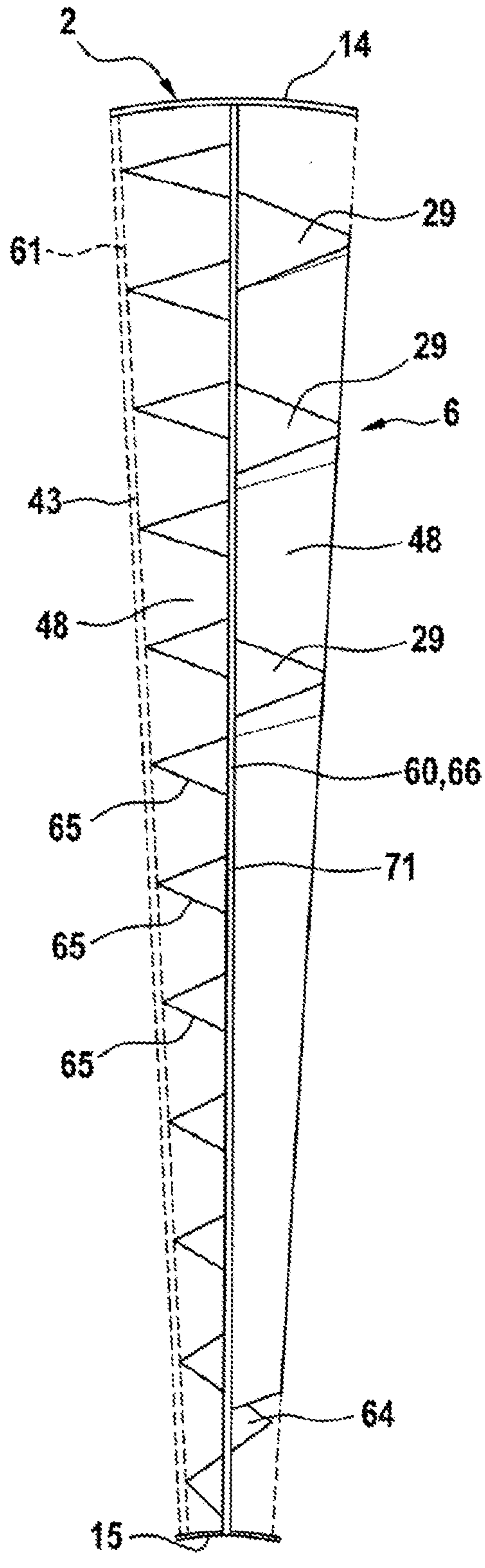


Fig. 10



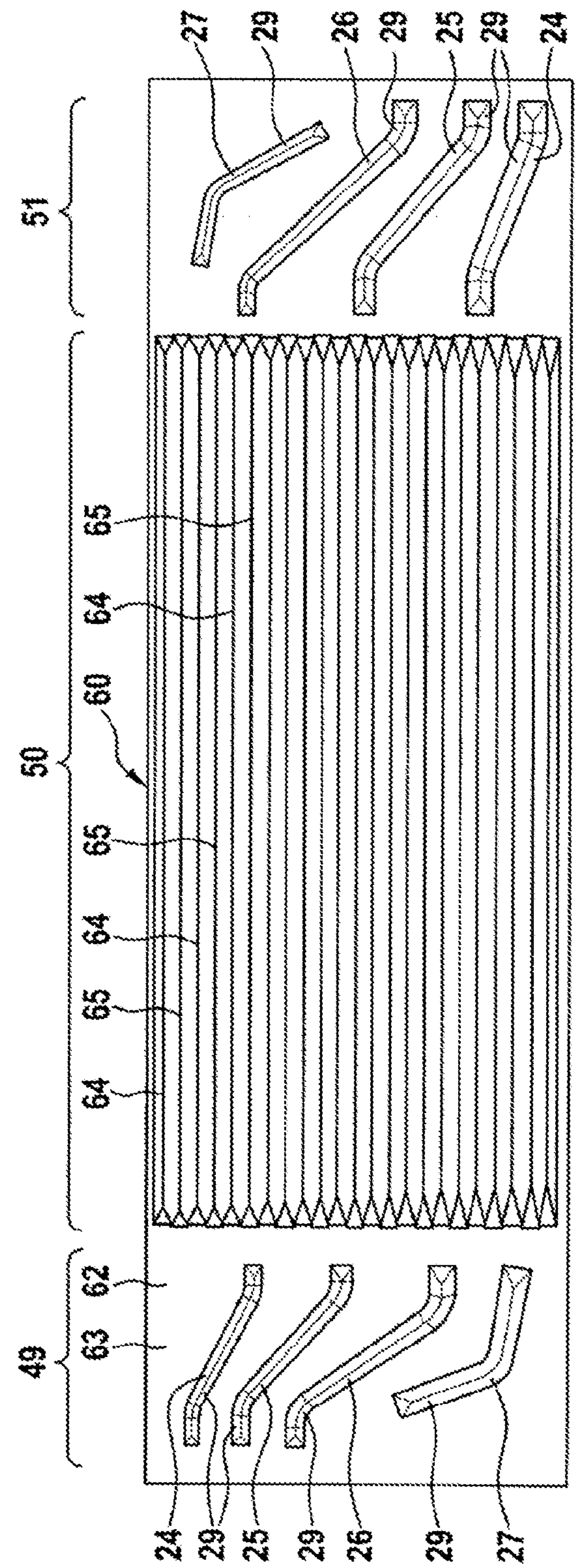

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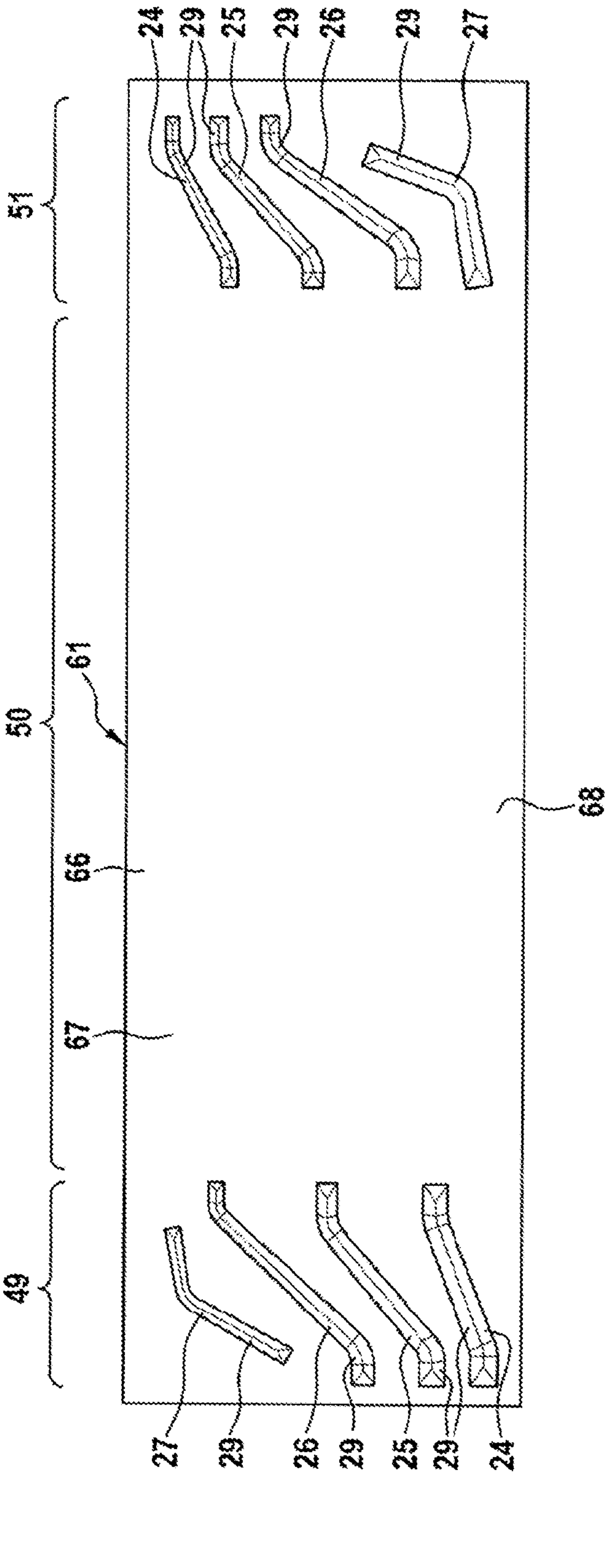
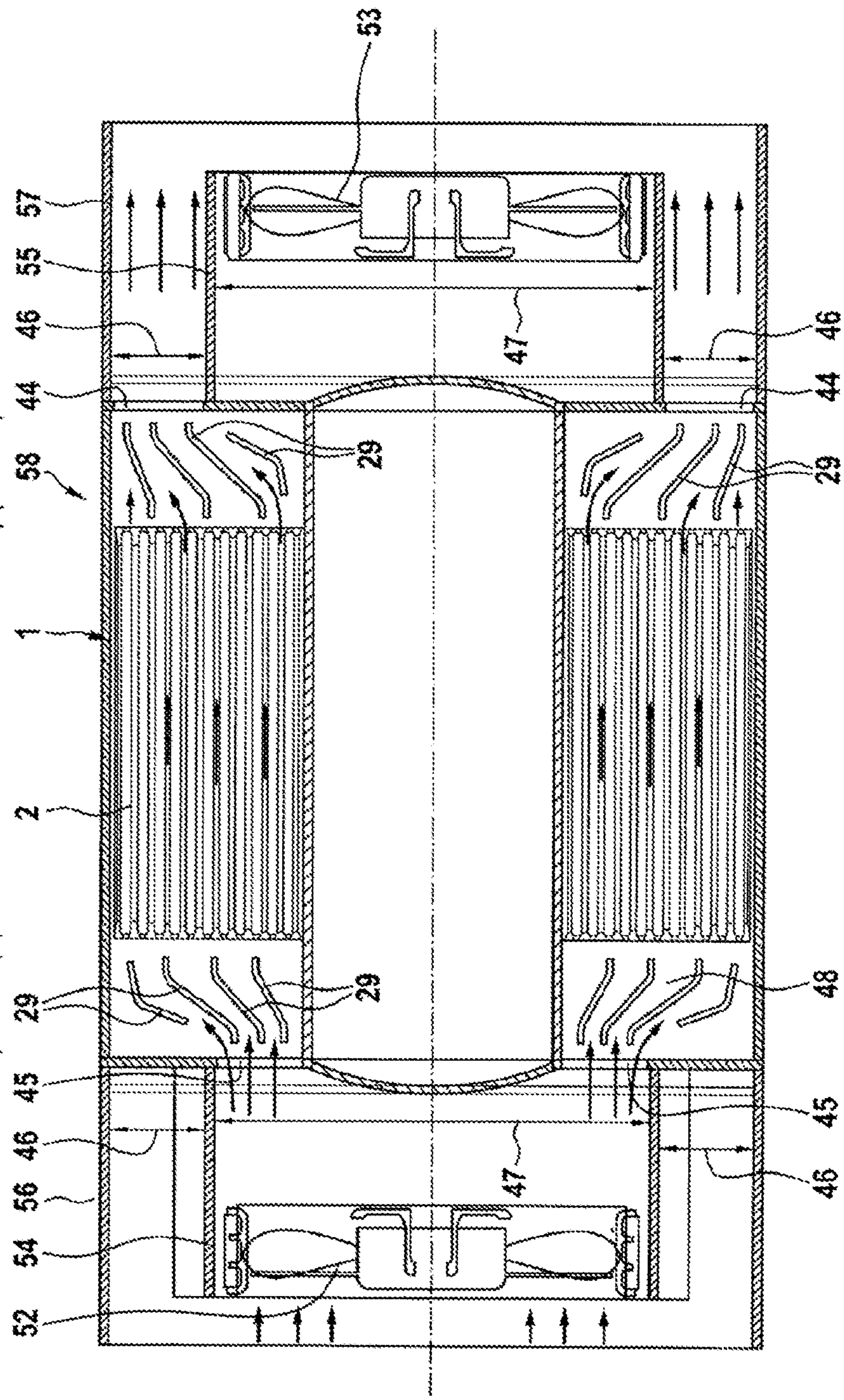
Fig. 11

Fig. 12





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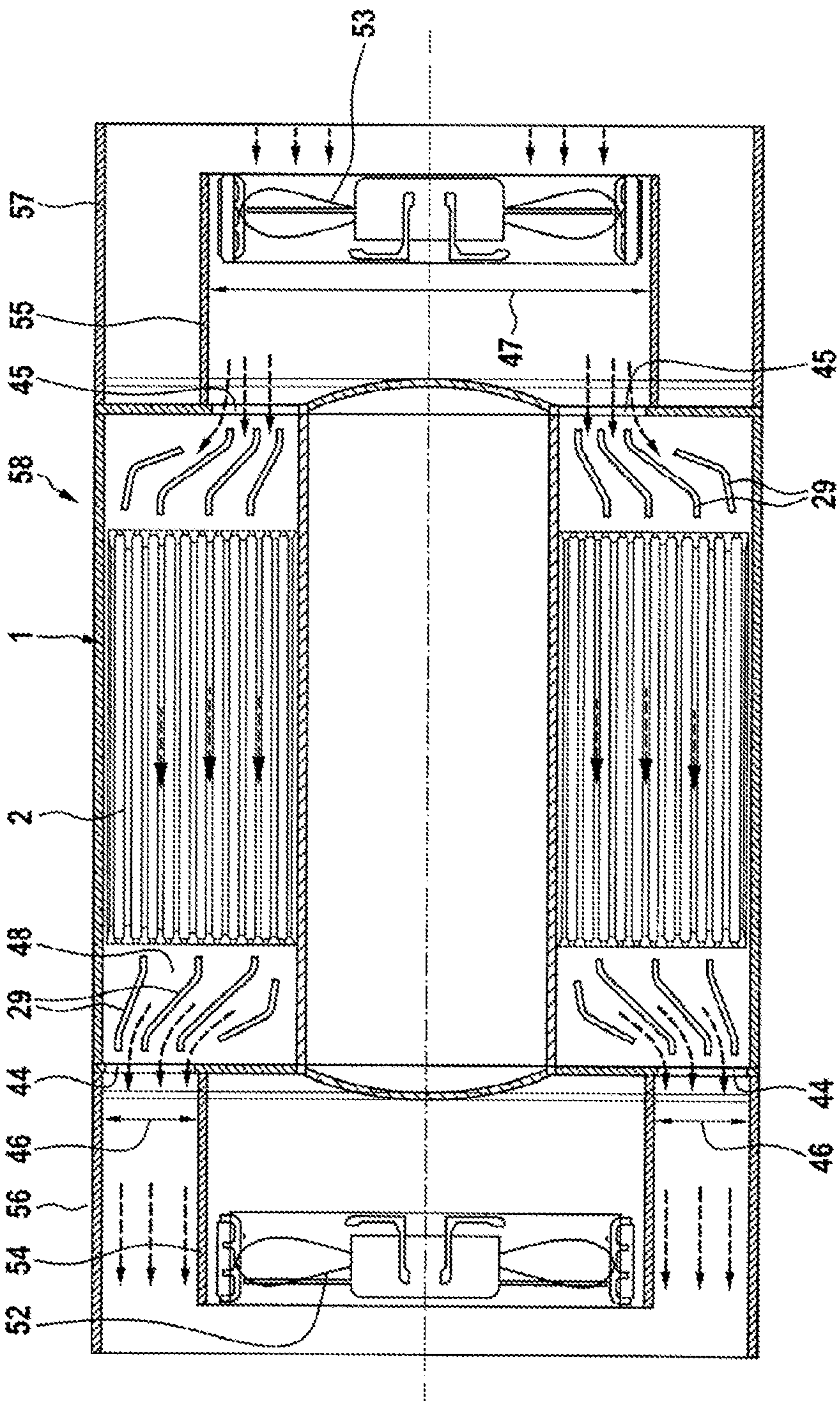
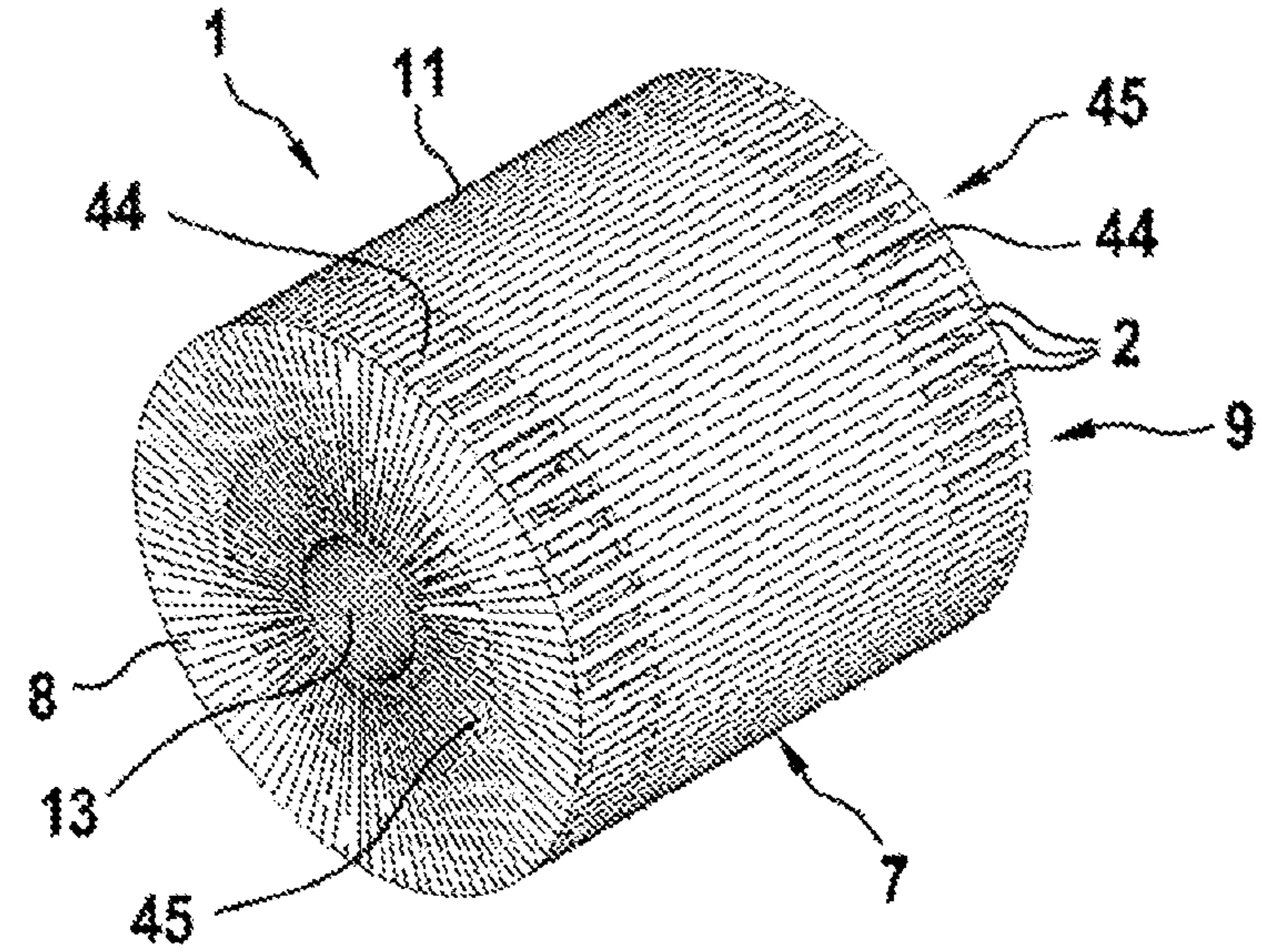


Fig. 14

Fig. 15



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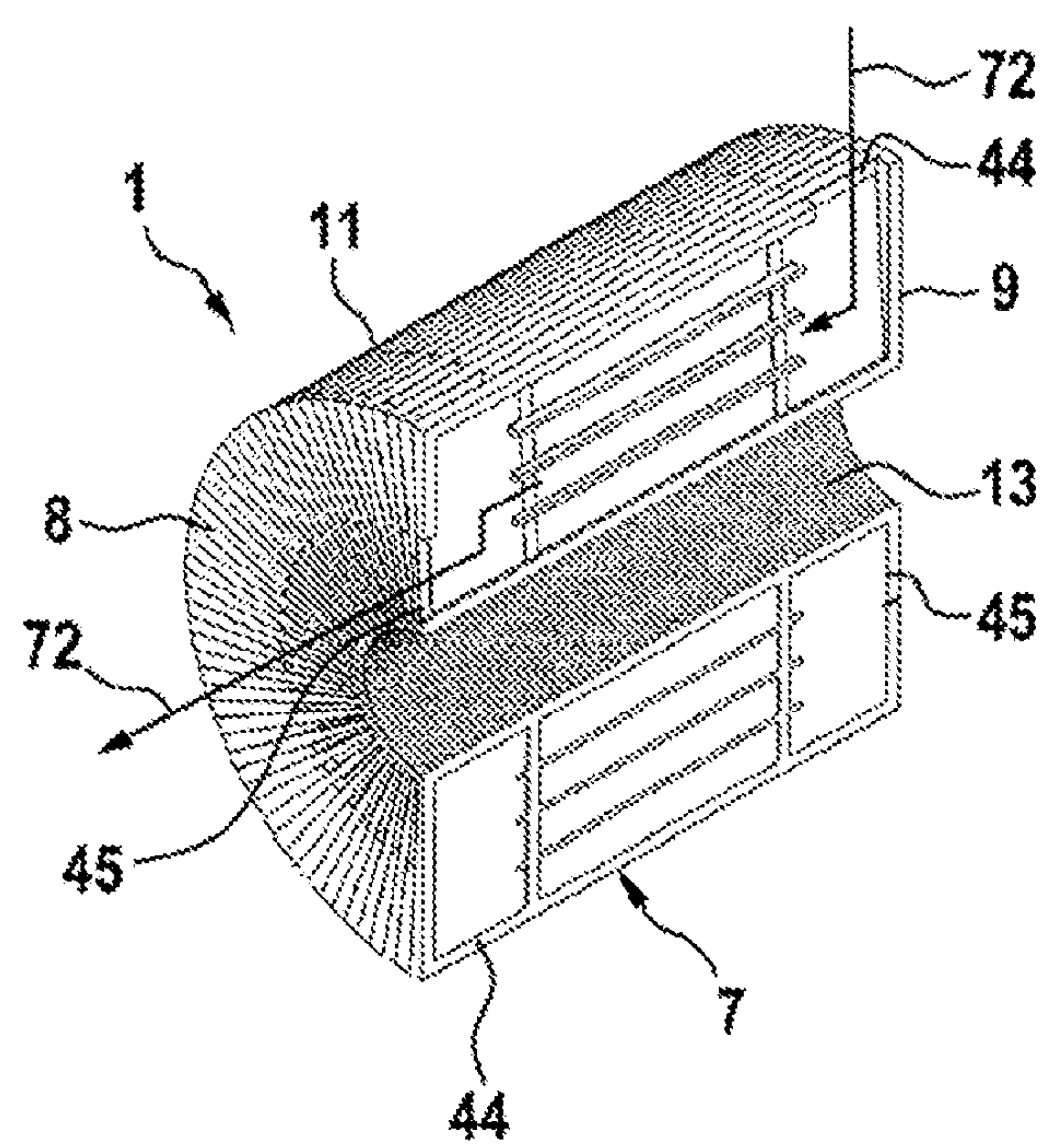
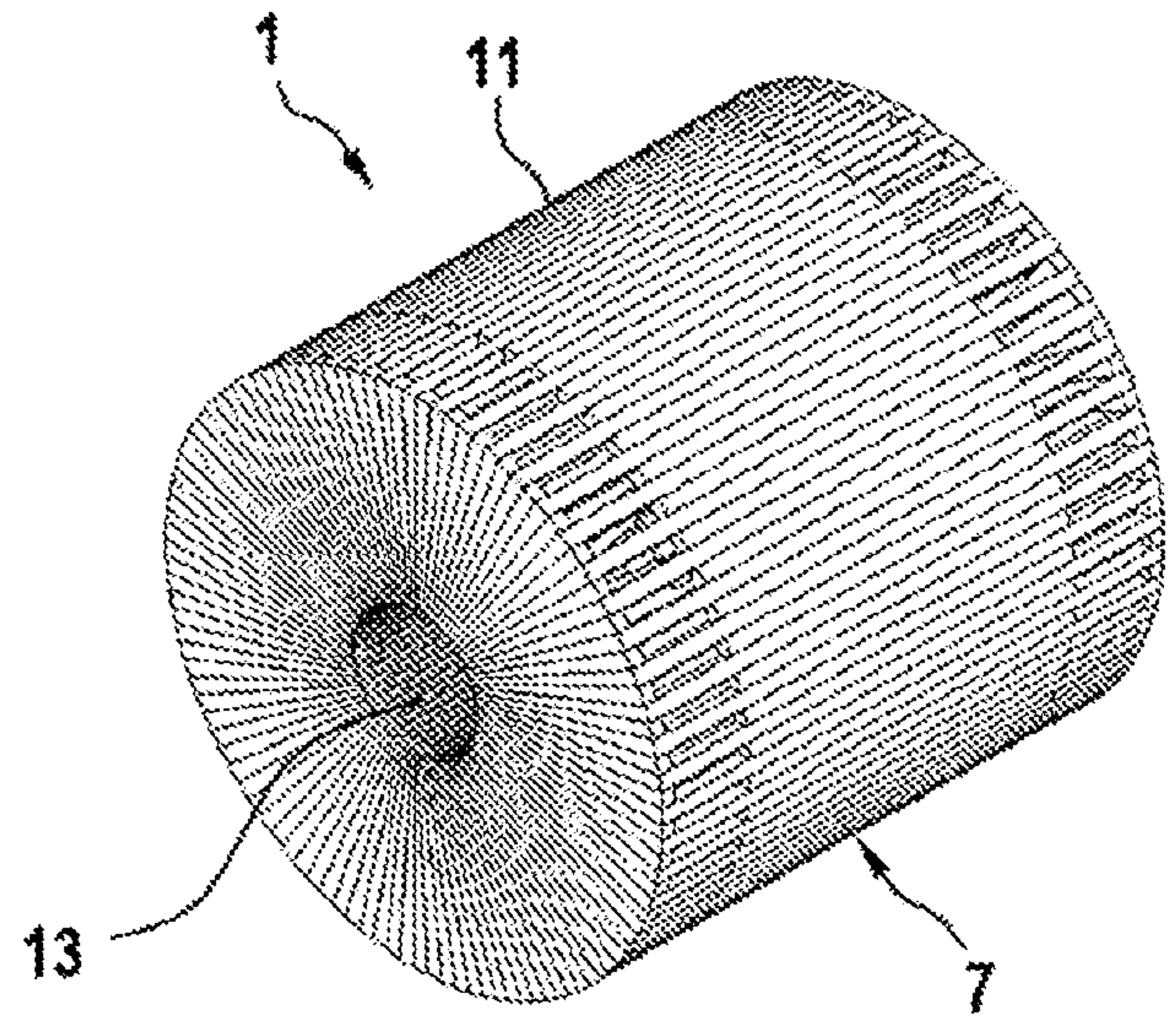


Fig. 17



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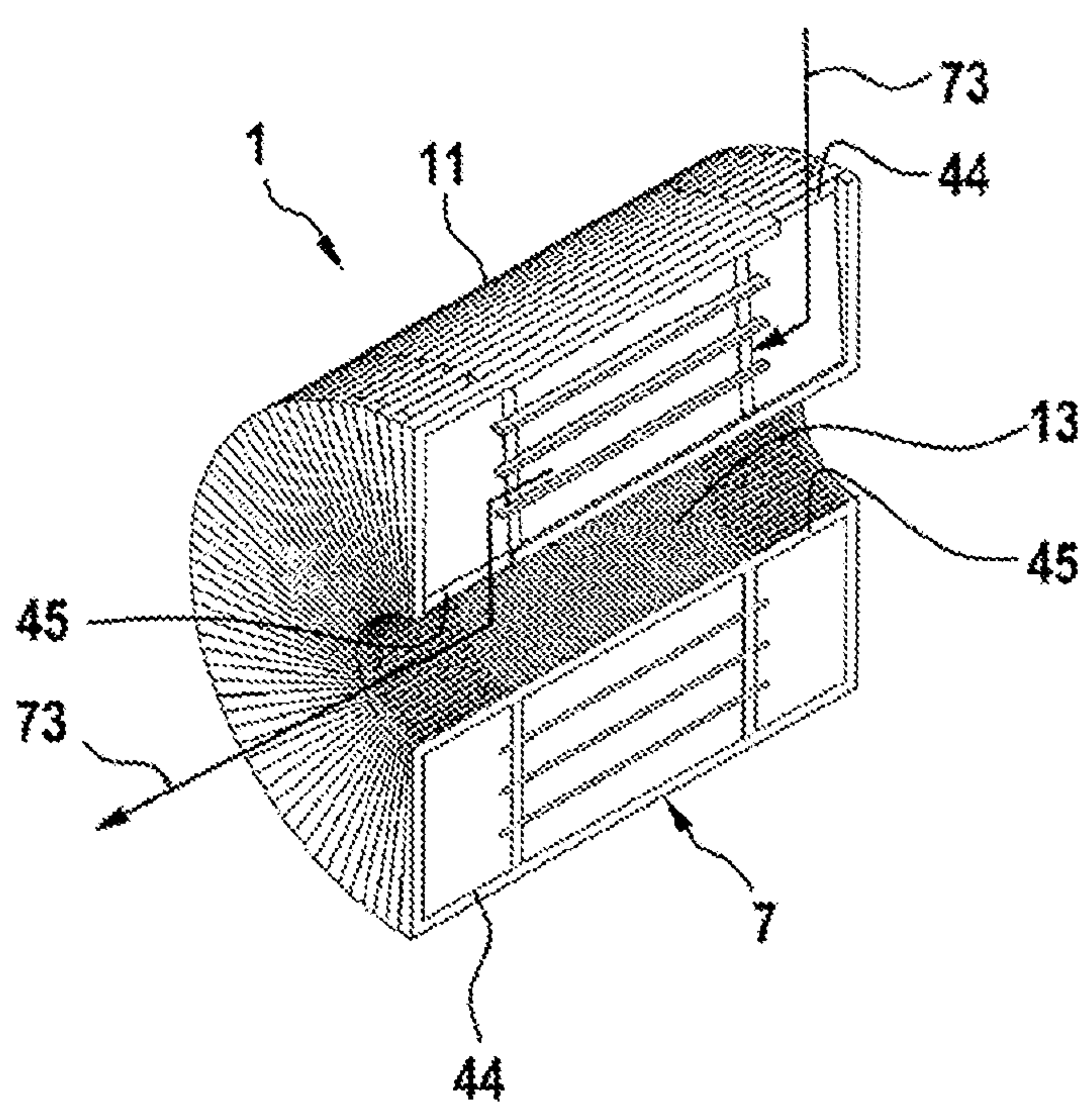

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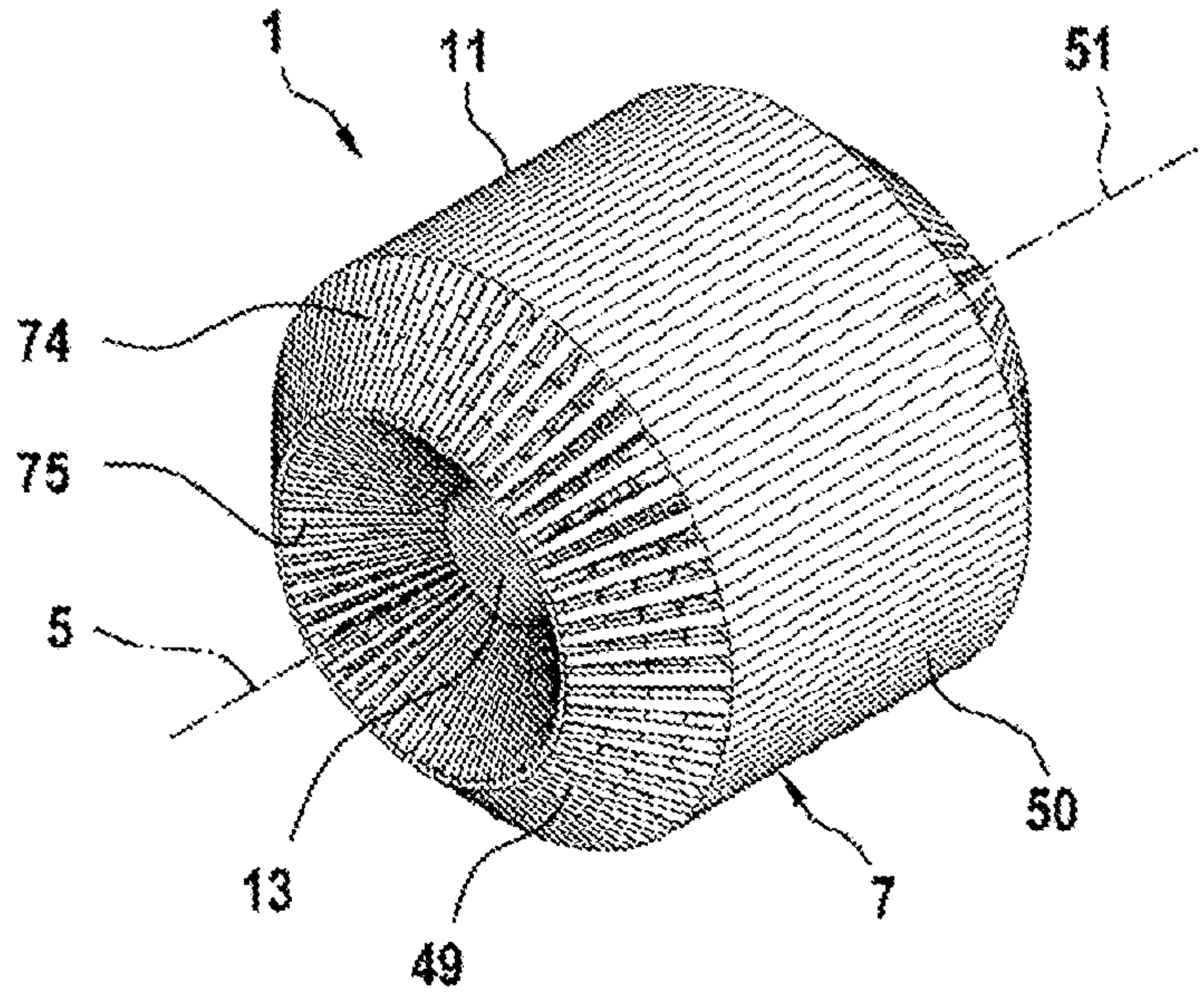

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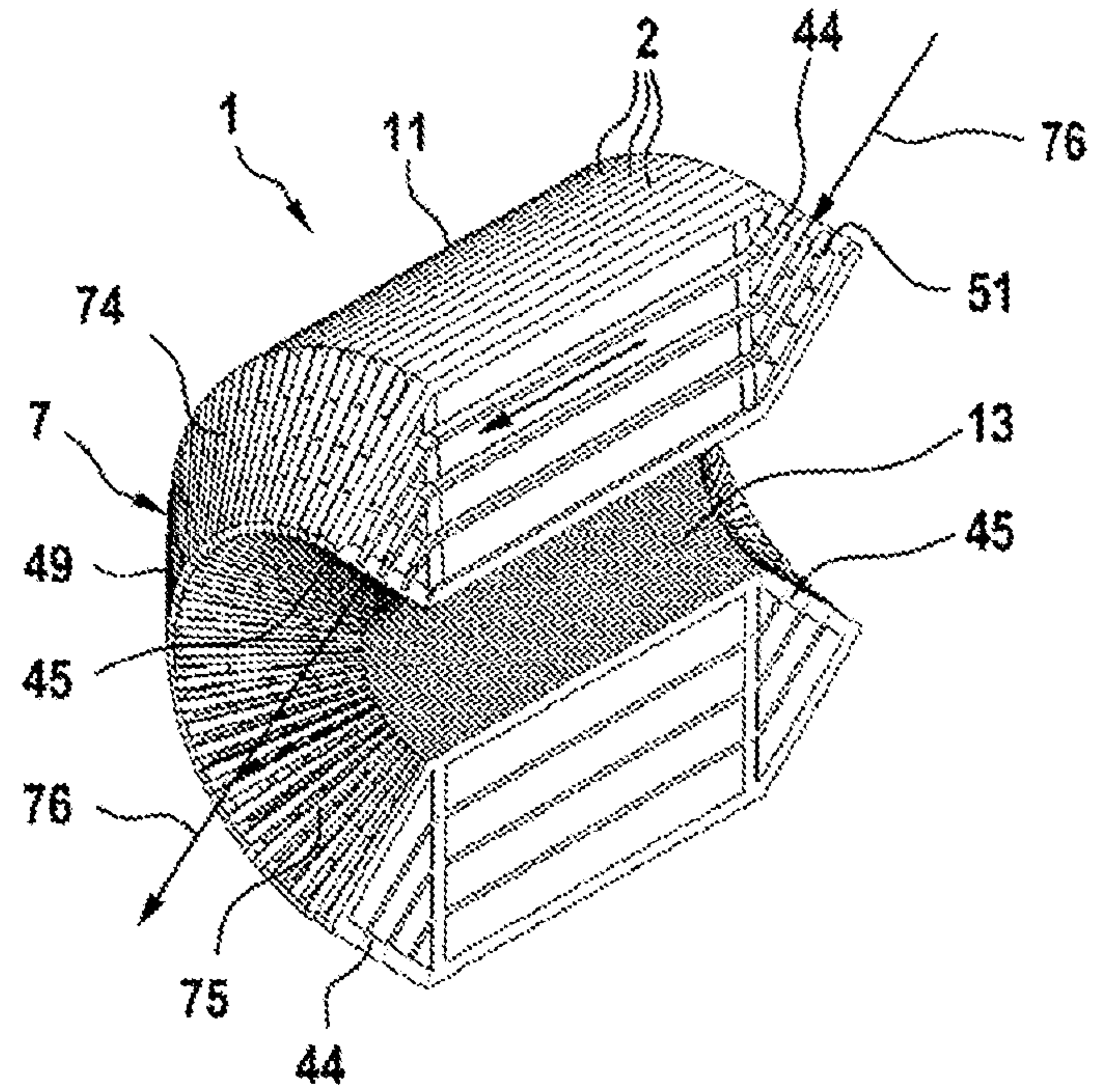

Fig. 21

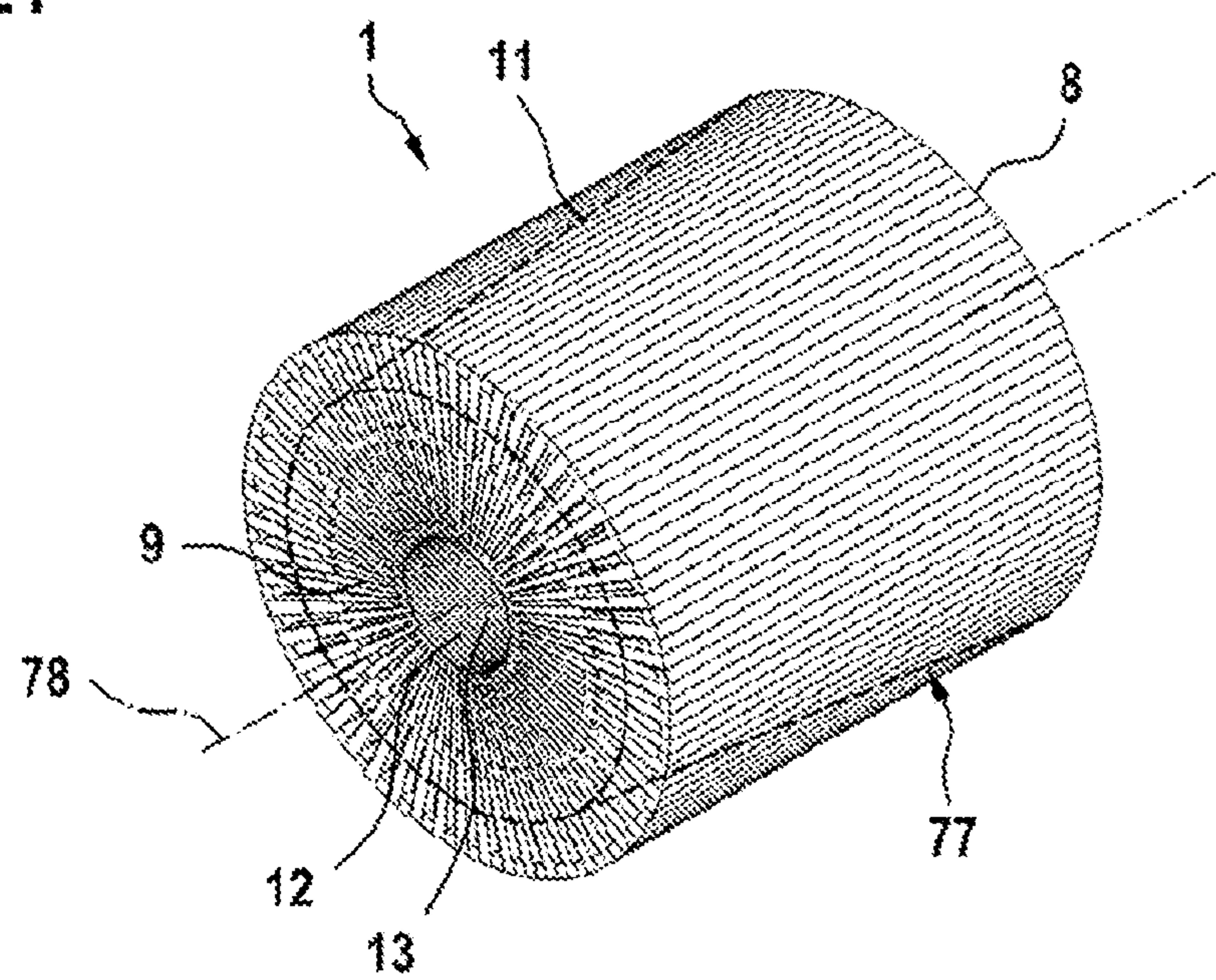

Fig. 22