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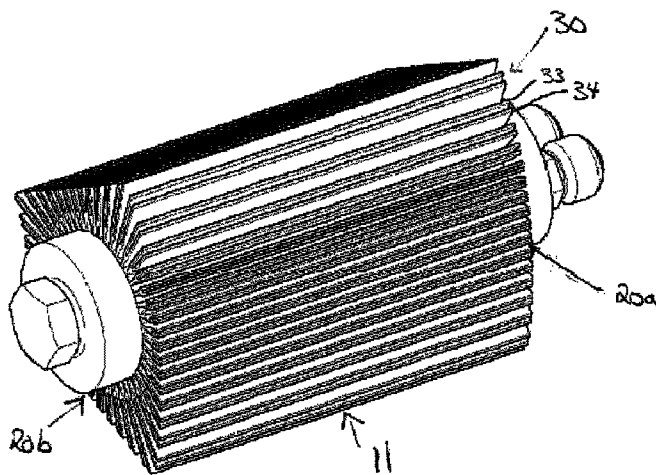
(54) Title **HEAT EXCHANGER**

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(57) Abstract

A heat exchanger for transferring heat between two fluids or with different temperature. The heat exchanger comprises at least one heating exchange element (10, 11), said at least one heat exchange element (10, 11) having at least one core (20, 21) extending longitudinally through the heat exchange element, said at least one core (20, 21) being configured to contain a first fluid, said at least one heat exchange element (10, 11) having ribs (30) extending substantially in parallel with the at least one core (20, 21), said ribs (30) being in contact with a second fluid, flowing along said ribs.(30)



HEAT EXCHANGER

FIELD OF THE INVENTION

The present invention relates to a heat exchanger, whereby a first fluid having a
5 first temperature heats up or cools down a second fluid having a second temperature.

TECHNICAL BACKGROUND OF THE INVENTION

In general, heat exchangers are devices that transfer thermal energy between
10 two fluids without direct contact between the two fluids. A primary fluid is typically directed through a fluid core of the heat exchanger while a secondary cooling or heating fluid is brought into external contact with the fluid core. In this manner, thermal energy may be transferred between the primary and secondary fluids through the walls of the fluid core.

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The ability of the heat exchanger to transfer thermal energy between the primary and secondary fluids depends on, amongst other things, the surface available for the heat transfer and the thermal properties of the exchanger materials.

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A vast number of various types of heat exchangers exist in the field. One of these is US 20090084520, which shows a heat exchanger comprising a plurality of hexagonal elongate elements, each of the elements having a central channel for a flow of a first fluid. Around the central channel, the elements comprises a
25 metal foam, which can be of an open cell structure or a combination of an open cell structure and a closed cell structure. A second fluid flows through the metal foam.

Publication US 637235 discloses a heat exchanger formed by several heat
30 exchanger elements arranged adjacent each other. Each heat exchanger

element having a core and ribs extending radially from the core. Some of the ribs are divided into two fins so that a hexagon is shaped by the elements and some are only prolonged as one fin. This shape of the heat exchanger elements results in large space between the ribs and fins of different heat
5 exchanger element and also creates a space between the surrounding casing and a heat exchanger element in certain areas of the heat exchanger. The heat exchange between the first and second fluid will thus be uneven.

A major disadvantage of this heat exchanger is that the metal foam provides a
10 very high flow resistance to the flow of the second fluid.

Other known heat exchangers are shown in DE2742877, BE673093, IT7848277, US3595310, US2729433, US20090107853, EP305702, AU7943132, GB1413913, US20140000845 and WO201091178. However,
15 common to these is that the flow of one of the fluids is restricted by elements of the heat exchanger. These restrictions increase the need of energy (pressure) to ensure a sufficient flow of the fluid.

Publication GB 637235 discloses a heat exchanger for heating or cooling sugar
20 syrup. The heat exchanger comprises a plurality of heat exchange elements arranged adjacent each other. Each heat exchange element comprising a core extending longitudinally through the heat exchanger element and ribs extending radially outwardly from the core, substantially in parallel along the whole length of the core. Some of the ribs are divided into two fins at a radial distance from
25 the core. The fins are arranged to form L- shapes and Y-shapes. This makes it possible to form hexagonal passages between the cores for the syrup to pass through. The shapes of the heat exchanger elements results in uneven transferring of the heat in the heat exchanger as there are areas that are not covered by the fins.

30 None of the publications DE2615168, JPS61225580, GB3713478, CN201229141, DE29510190, US813918, US4657074 discloses heat exchangers with heat exchanger elements where the rib extending continuously

substantially radially outwardly from a core and are divided into two radially extending fins that are extending to a proximity of a casing surrounding the heat exchanger or to a proximity of the fins of a second heat exchanger element arranged adjacent said heat exchanger element.

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Heat sinks are used in electronic system to cool for instance central processing units or graphic processors by dissipating heat into the surrounding medium.

Heat sinks having fins that extend from its base and increase the area of heat transfer. The base and fins are in direct contact with the heat source for cooling
10 of the electrical unit.

The heat exchanger according to the invention are not equivalent to the heat sinks for cooling central processing unit or similar electrical units, the heat sinks are much smaller to fit in the electronic device than the heat exchanger
15 according to the invention. In the heat exchanger according to the invention, the heat is transferred from a fluid to another fluid to be used as a heating or cooling of a surrounding gas or a liquid.

SUMMARY OF THE INVENTION

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Consequently, there is a need to provide a heat exchanger that ensures a high flow with a minimum of energy consumption to provide the flow. It is also a need to provide a heat exchanger where there is a minimum of loss of pressure difference with an increased flow rate.

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Another advantage of the heat exchanger according to the invention is that the surface area of the heat-exchanging element is higher, which results in a more efficient heat transfer.

30 The material of the heat exchanger causes less incrustation. The exchanger

elements are also easier to clean because it can be done by a high-pressure washer.

The objective of the invention is achieved by a heat exchanger for transferring
5 heat between two fluids with different temperatures. The heat exchanger
comprises at least one heat exchange element, said first heat exchange
element having at least one core extending longitudinally through the heat
exchange element. Said at least one core being configured to contain a first
10 fluid, said first heat exchange element having ribs extending continuously
substantially in parallel with the at least one core along the whole length of said
core, said ribs extending radially outwardly from the core and being exposed to
contact with a second fluid, flowing along said ribs. The invention being
distinctive in that said each rib is divided into at least two radially extending fins
15 at a radial distance from the core, said each fin extends to a proximity of an
outer casing surrounding said first heat exchanger element or to a proximity of
the fins of a second heat exchanger element, said second heat exchanger
element being arranged adjacent the first heat exchanger element thereby
transferring heat from the first fluid to the second fluid evenly throughout the
heat exchanger.

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Preferable embodiment of the heat exchanger are defined in the dependent
claims, to which reference is made.

BRIEF DESCRIPTION OF THE DRAWINGS

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Figure 1 shows a principle drawing of a heat exchanger according to the
invention.

Figure 2 shows in elevated view the main parts part of the heat exchanger
30 according to the invention in an exploded view.

Figure 3-Figure 4 shows the heating element, viewed from opposite sides of the heating element.

- 5 Figure 5-7 shows the heating element without the casing. Figure 6 and 7 are viewed from opposite sides.

Figure 8-9 shows an elevated view of the heating element without pipes or tubes.

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Figure 10 shows an elevated view of the heat exchange elements and the first plugs and fluid supply arrangement.

- 15 Figure 11 shows an elevated view of a first plug with inlet and outlet adapter and guiding pipe.

Figure 12 shows a cross section of the core of the heat exchange element with plugs arranged at both ends of the core and a threaded rod extending between the plug.

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Figure 13 shows an elevated view of the side heat exchange elements and the centre heat exchange element.

Figure 14 shows a principle drawing of one single side heat exchange element.

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Figure 15 shows a detailed view of the ribs and fins of the side heat exchange element from Figure 14.

Figure 16-17 shows a detailed view of different embodiments of the centre heat exchange element.

Figure 18 shows a detailed view of another embodiment of the centre heat
5 exchange element with a separate inner core element with ribs.

Figures 19-20 show different embodiments of inner core elements with ribs.

Figures 21-29 show different constructions of the heat exchange elements
10 forming the heat exchanger.

Figures 30-32 show different embodiments of the arrangement of the supply of fluid in the heat exchanger and between the heating or cooling elements.

15 Figures 33-35- show detailed views of a possible embodiment of the heat exchanger according to the invention.

Figures 36-50 show different embodiments of the invention where the heat exchanger comprises a central heat exchange element and is arranged without
20 side heat exchange elements inside a duct for transferring of heat between two fluids.

Figure 36-38 shows the embodiment with a centre exchange element not restricted by a cylindrical outer element attached to the centre exchange
25 element, the centre heat elements as described in figure 16-18 may be used in this embodiment of the invention.

Figure 39a-39b shows the centre heat exchange element with a cylindrical outer element fixedly connected to the centre heat exchanger.

Figure 40-46 shows an embodiment of the present invention where the centre heat exchange element of Figure 39a-39b is used.

- 5 Figures 47-50 show another embodiment of the heat exchanger where the heat exchanger comprising a centre heating exchanger element and a plurality of side heat exchange element. The heat exchanger is arranged inside a duct adapted to transferring heat between two fluids.
- 10 Figure 51 shows another use of the heat exchanger according to the invention where the heat exchanger is used to heat air that is led trough the heat exchanger by a fan.

DETAILED DESCRIPTION OF THE INVENTION

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- Figure 1 illustrates a heat exchanger 1. It facilitates transfer of thermal energy between two or more fluids. The fluids may include liquid, gases or any combination of liquid and gases. For example, the fluids may include air, exhaust, oil, coolant, water or any other fluid known in the art. The heat
- 20 exchanger may be used to transfer thermal energy in any fluid systems, such as for example, an exhaust and /or air cooling system, a radiator system, an oil cooling system, a condenser system or any other type of fluid system known in the art.

- 25 Figure 2 shows a partially exploded elevated view of the heat exchanger according to one embodiment of the invention. The heat exchanger 1 comprising a housing 3. This housing 3 is shown cylindrically shaped but it could also have other shapes, like a rectangular shape.

- 30 A heating element 2 according to the embodiment of the invention is arranged

within the housing 3. At both ends of the housing 3, there are arranged lattices 4, 5 to provide protection for the heat exchanger.

Figure 3 discloses the heating element 2 according to the invention in greater
5 detail. The heating element 2 comprises a plurality of heat exchange elements 10, 11. Each heat exchange element 10, 11 has a core 20, 21 in the centre of each of the heat exchange elements 10, 11. The core 20, 21 extends in the longitudinal direction of the heating element 2 with opening in both ends of the core 20, 21. The ends are further defined as a first end 20a, 21a (see also
10 figure 10) of the core and a second end 20b, 21b of the core 20, 21. The cores 20, 21 are sealed with a first plug 22 in the first end 20a, 21a and a second plug 13 at a second end of each of the respective cores 20, 21. The cores 20, 21 are adapted to be filled with heating agent or alternatively a coolant depending on what the heat exchanger should be used to.

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The figure 3 further shows a centre heat exchange element 10 defining the centre of the heating element 2 and a plurality of side heat exchange element 11 located adjacent the centre heat exchange element 10.

20 At least one ring 15 is extending around the heat exchange elements to lock the heat exchange elements together. The ring 15 is best shown in Figures 5-9. In these figures, there are illustrated two rings 15 extending around the heat exchange elements at each end of the heating element 2.

25 There is also shown a casing 16 extending around the periphery of the heat exchange elements 11.

Figure 4 discloses the heating elements 2, viewed from the opposite side than Figure 3. There are a plurality of pipes or tubes 12a, 12b, 12c arranged
30 between the cores 20, 21 in order to establish a fluid communication between the cores 20, 21. The pipe or tubes 12a, 12b, 12c could also be arranged so

that the cores are coupled in parallel configuration instead of the serial configuration shown. This is described later.

5 An inlet pipe or tube 12a forms the link between the supply source (not shown) of the heating fluid and the inlet of the first end 21a of the centre core 21 in the centre heat exchange element 10. The free end of the pipe or tube 12a preferably has a male sleeve coupling 17a for quick and easy connection with the supply source. This connection is preferably drip-free.

10 The connection could be a quick release coupling to the supply tube or pipe or the discharge tube or pipe.

There is another pipe or tube 12b extending between a first end 21a of the centre core 21 and a first end 20a of the side core 20. In addition, there are
15 similar pipe or tubes 12b extending between two lateral side cores 20 of the side heat exchange elements 11 as shown in Figure 4.

Different configurations for the connection between the heat exchange elements 10,11 are shown in Figures 25 -31. It is also possible to make the heat
20 exchanger 2 in one element with several cores 20, 21. This is described below.

The outlet pipe or tube 12c is in one end coupled to the first end 20a of a side core 20 and the other end is adapted to be connected to a device for receiving the fluid flowing through the cores and which is to be heated or cooled.

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The free ends of the outlet pipe or tube are adapted to be connected to arrangements for supply of fluid and discharge of fluid from the core. For instance, the free ends of the outlet pipes of tubes (12a, 12c) could be provided with quick release coupling for connecting with pipes of tubes attached to the
30 supply/discharge arrangement. Other connection arrangement are also possible.

The inlet pipe 12a could optionally be arranged in connection with one of the side cores 20 and the outlet pipe 12c could optionally be arranged in connection with the centre core 21. Inlet and outlet to any of the side cores 20 or the centre core 21 are possible embodiments of the invention. The figure 4 shows just one possible arrangement.

Another possible embodiment of the arrangement of the pipes 12a, 12c is that there are separate inlet pipes or tubes 12a and separate outlet pipes or tubes 12c to cores 20, 21 and that there is no pipe or tube 12b between the cores 20, 21. This is illustrated in Figure 31.

Figure 5, 6 and 7 shows the heating element 2 without the casing 16. The position of the rings extending around the heat exchange elements 20, 21 are shown in greater detail in this figure.

The heating elements are in Figure 5 and 6 viewed from the second, or front, side, i.e. the opposite side of the heating or cooling fluid inlet and outlet.

The cores 20, 21 are in this second end sealed with second plugs 13 and screws 14. The second plug 13 has packer element 13a (see also figure 12) that provide a sealing closure between the core 20, 21 and the plug 13.

In Figure 7 the heating element is viewed from the first, or rear, end, i.e. the inlet and outlet side of the heating or cooling fluid.

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Figure 8 shows an elevated view of the heating element 2 where the pipes or tubes 12a, 12b, 12c are removed.

Figure 9 and 10 shows the heating element without the pipe or tubes 12a, 12b, 12c. At the first ends of the cores 20, 21 there are arranged first plugs 22, each

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with a sealing packer element 23 (see figure 10). The first plug 22 has similar configuration as the second plug 13 and is arranged in each of the cores 20, 21 at the first end to seal fluid within the cores 20, 21.

- 5 The first plug 22 comprises two openings or holes 22a, 22b extending through the first plug 22, the holes 22a, 22b are arranged next to each other. In connection with the respective openings 22a, 22b there is arranged an inlet adapter 24 and an outlet adapter 25 at the outside of the first plug 22. The inlet and outlet adapters 24, 25 connects the respective inlet pipe or tube 12a (Figure 4) and outlet pipe or tube 12c (Figure 4) together with the first plug 22 and consequently there is a fluid communication established between the pipe or tubes 12a, 12b, 12c and the core 20, 21.

- At the inside of one of the openings 22a, opposite of the first plug 22, there is arranged a pipe 26 which can be screwed into the inlet opening 22a in the inlet adaptor 24 of the first plug 22. This pipe 26 is extending towards the second plug 13 at the inside of the core 20, 21 in order to provide circulation of the heating fluid in the core 20, 21. This will be described in further detail below. The first plug 22 and the components attached to the plug 22 is shown in greater detail in Figure 11 and 12.

- A threaded rod 27 extends through the core 20, 21 and is attached to the first plug 22 in a first end. A second end is extending through an opening or hole 13b in the second plug 13. A nut 50 and washer 51 (Figure 12) is arranged at the second end of the rod 27 to secure the second plug 13 to the core 20, 21 via the rod 27. The threaded rod 27 is securing the first plug 22 and the second plug 13 (Figure 6, 12) together at both ends of the core 20a, 20b, 21a, 21b. This is shown in Figure 12.

- 30 Figure 13 shows an exploded elevated view of the side heat exchange element 11 and the centre heat exchange elements 10.

The centre heat exchange element 10 is in this embodiment surrounded by side heat exchange element 11 in a circle around the periphery of the centre heat exchange element 10. The surface of the side heat exchange element 11 has at the side facing the centre heat exchange element 10, a curved shape which is complementary to the shape of the outer surface of the centre heat exchange element 10.

Other embodiments of the invention could have other shapes as shown in the accompanying drawings, as seen particularly in Figure 25-26 where there is no centre heat exchange element 10. The outer periphery of the side heat exchange element 11 could also have different shapes depending on the shape of the casing surrounding the side heat exchange element 11, such as in particular shown in Figures 21-29.

Figure 14 shows a principle drawing of a single side heat exchange element 11 with a core 20 extending from a first 20a end to a second end 20b. The core 20 is at the ends delimited by the first plug 22 and the second plug 13. The core 20, 21 has a cylindrical shape, but other shapes are also possible, for instance cubical. This applies both for the centre heat exchange element 10 and the side heat exchange element 11.

The side heat exchange element 11 as well as the centre heat exchange element 10 comprises a plurality of longitudinal ribs 30. Each rib 30, 31 is extending substantially in parallel with the core 20, 21 and radially outwardly from a surface defining the core 20, 21.

Figure 15 shows a detailed view of the ribs 30 of the side heat exchange element 11.

Figures 16-17 and also Figure 39a-39b shows detailed view of different embodiments of the centre heat exchange element 10.

The surface defining the core 20, 21 is shown as a core surface 20c. The ribs 30, 31 are extending radially outwardly from the core surface 20c.

The ribs 30 are preferably made of metal or with a smooth surface so as to
5 provide low surface friction, enabling the heated or cooled fluid to pass through the heat exchange element with a minimum of resistance from the ribs 30.

At a radial distance from the core surface 20c the rib is preferably split into two or more fins 33 and 34 to increase the surface area and thus the area that can
10 transfer heat. Figure 15 shows a first fin 33 and a second fin 34 that are extending substantially parallel to each other radially outward. The shape of the ribs 30, 31 and fins 33, 34, 35, 36 could be different in different configurations of the heat exchangers 2 and are also depending on the use of the heat
15 exchanger 2, 100. For instance if the viscosity of fluid, flowing through the gaps between the ribs 30, 31, is high, it is more suitable to have a greater distance between the fins 33, 34, 35, 36 and/ or the ribs 30, 31 than if the viscosity of the fluid is lower. The ribs 30, 31 and fins 33, 34, 35, 36 preferably extend all along the length of the core 20, 21. The radial extent of the ribs 30, 31 and the fins 33, 34, 35, 36 could also be different in different configurations of the heat
20 exchanger 2, 100.

The centre heat exchange element 10 has similar configuration with ribs 31 and fins 35, 36 as the side heat exchange element 11. This is shown especially in
25 Figures 16-17, which show different embodiments of the centre heat exchange element 10.

The inside surface of the core 21c in the centre heat exchange element 10 could also be smooth as shown in the side heat exchange element 11 according to another embodiment of the invention. The side heat exchange
30 element 10 could as an option have ribs 37 extending radially inwards from the core 20c similar to the embodiments of the centre heat exchange elements 10 shown in Figure 16-18.

In a further embodiment of the invention, each of the inner ribs 37 could be split into two radially extending fins 38, 39 as shown in Figure 17.

- 5 The inner ribs 37 could optionally be arranged in a separate inner core element 40 that may be press fit into the centre heat exchange element 10 at the inside of the core 21. This is shown in Figure 18. This separate inner core 40 shown in Figure 19-20 could also be suitable for use in side heat exchange element 11.
- 10 Figures 19 and 20 show the inner core element separate from the centre heat exchange element 10 with different configurations of the inner ribs 37.

The centre and side heat exchange elements 10, 11 and also the inner core element 40 can be extruded, so that the core surface 20c, 21c and ribs 30, 31
15 with fins 33, 34, 35, 36 are made in one piece and of one material. Suitable material for the heat exchange elements and inner core element 40 are materials with high thermal conductivity, such as metal, for instance aluminium or copper. Other metals that have good heat conductivity and are possible to extrude, may also be used. The heat exchanger could also be extruded in one
20 piece with a plurality of cores to a shape as for instance as shown in Figure 21 or 22.

The heat exchange elements 10, 11 could also possible be made from 3D printing of the elements 10, 11 or 40. The development of 3D printing is fast and
25 this may prove to be a feasible method in the near future, especially for producing smaller sized heat exchangers 2.

Figures 21-29 show different designs of the heat exchange elements 10, 11 and different assembly configurations of the heat exchanger.

In Figure 21, the centre heat exchanger element is cylindrical and eight side heat exchange elements 11 are arranged in on the outside of the centre heat exchange element 10 forming a cylindrical ring surrounding the centre heat exchange element 10. This heating element has nine cores 20, 21 adapted for
5 the supply of the heating agent or coolant.

In Figure 22 the centre heat exchange element 10 has a similar cylindrical shape, but there are only four side heat exchange elements 11 on the outside of the centre heat exchange element 10 surrounding the centre heat exchange
10 element 10. The heating element 2 thus having five cores 20, 21 for supply of the heating agent or coolant. The fins extending radially outwardly from the core are also longer than in the embodiment described in Figure 22. The gap between the ribs 30 at their outer portions will therefore be larger.

15 Figure 23 shows yet another embodiment of the invention with different shape of the heat exchanger. This results in a different shape of the side heat exchange elements 11. In this embodiment, the heat exchanger has a cubic shape. The outer surfaces of the side heat exchange elements 11 are straight and perpendicular to each other. The centre heat exchange elements 10 is
20 cylindrical, resulting in that the surface of the side heat exchange elements 11 is concave and has a corresponding curved shape as the outer surface of the centre heat exchange element 10.

Figure 24 shows yet another possible embodiment of the invention, where a
25 plurality of the heat exchange elements shown in Figure 24 are assembled to form a heat exchanger with a plurality of centre heat exchange elements 10 and a plurality of side heat exchange elements 11.

Figures 25-26 show another embodiment of the invention where the heat
30 exchanger is composed of four side heat exchanger elements 11. In this embodiment, there is no centre heat exchange element 10.

Figure 27 shows the same embodiment of the invention as shown in Figure 21 with tubes or pipes 12b arranged between the cores

- 5 In Figures 28 and 29 there is an additional layer of side exchange elements 111 arranged in a circle around the initial layer of side exchange elements 11 .

The number of side heat exchange elements 11 is not limited to the embodiments of the drawings. Other numbers of side heat exchange elements
10 11, 111 suitable for the invention is also possible.

Each of the heat exchange element 10, 11, 111 forming the heat exchanger in the figure 21-29 could be assembled by separate heat exchanger element that are adjoining each other in a preferred shape.

- 15 It is also possible within the invention to make a heat exchanger element 10 with a plurality of cores 20, 21 integrated in one heat exchange element, like for instance a shape similar to the shape in Figure 21.

Figures 26-30 also show a possible fluid communication between the different
20 heat exchange elements 10, 11. There is shown a transfer of fluid from the core 20, 21 of one heat exchange element 10, 11 to the core 20, 21 of the adjacent heat exchange element 20, 21. The fluid is transferred through pipes or tubes 12b and openings 24 as shown in Figure 4 and 9-10.

- 25 The fluid could be supplied to the centre heat exchanger 10 and thereafter through all of the side heat exchangers 11, 111 before the fluid is discharged from the heat exchanger 2. The fluid could optionally be supplied to one of the side heat exchange element 11, 111 and thereafter through all of the side exchanger element 11, 111 before it is discharged from the centre heat
30 exchange element 10 or from one of the other side exchange element if there

are no centre exchange element 10 as in Figure 26.

Figure 31 shows another configuration of the supply of fluid to and the return of fluid from the heat exchanger 2. In this Figure there are no pipes or tubes 12b,
5 i.e. no fluid connection, between the cores 20, 21 of the heat exchange elements 10, 11. The heat exchange elements 10, 11 have each a supply of fluid from a separate supply tube or pipe 12a and a separate outlet pipe or tube 12c for the return of fluid from the core 20, 21. The supply pipes 12a and the outlet pipes 12c are coupled to a common delivery and return pipe through a
10 respective manifold. Consequently, the fluid systems are arranged in parallel.

Figure 32 shows yet another arrangement of the supply and distribution of the fluid between the cores 20, 21. In this Figure, inlet and outlet adapters 24, 25 are arranged at opposite ends. This means that the supply tube or pipe 12a,
15 outlet tube or pipe 12c and the pipes or tubes 12b between the heat exchange element are arranged at both ends of the heat exchanger elements 10, 11.

Figures 33-35 show yet another embodiment of the invention. In this embodiment, the structure of the heat exchanger 100 is similar to the centre
20 heat exchange element 10 as described in in previous drawings. The core 20 has plugs 13, 22 arranged at both ends, the first plug has openings with an inlet adapter 24 and an outlet adapted 25, to let the heating medium or coolant flow into and out of the core. A threaded rod 27 is attached at both ends to the first plug 22 and second plug 13 to secure the plugs 13, 24 at the core ends 21a,
25 21b. The figures also show the pipe 26 extending from the inlet opening 22a towards the second plug 13 to provide circulation of fluid along the full length of the core.

The heat exchange element 100 has also here ribs 31 and fins 35, 36 extending
30 radially outwardly from the core 21.

In Figure 34 there is shown an embodiment with the inner ribs 37 as described in figure 16-18.

Figures 34 and 35 show both ribs 37 that are attached to the inner core surface
 5 20c and separate inner core element 40 that is arranged at the inside of the core.

Figures 36-51 show different use of heat exchange according to the invention.

10 Figures 36-38 show an embodiment of the heat exchanger where the heat exchanger 100, e.g. as described in Figures 34-3, is arranged within a duct 41. The heating medium or coolant is supplied and discharged via pipelines 12a, 12c connected to couplings that extends through openings in the walls of the duct 41. This arrangement is particularly suitable for heat exchanging liquid,
 15 such as for cooling oil. The duct 41 is liquid tight and the liquid to be heated or cooled down flows through the duct 41 in the longitudinal direction thereof.

Figure 39a-39b shows another embodiment of a centre heat exchange element 10'. In this embodiment there is a cylinder 50 attached on the outside of the
 20 centre heat exchange element 10'. The ribs 31 with fins 35, 36 are extending from the inner core to the outer cylinder 50. This is different from the embodiment of the heat exchange element 10 from Figure 16-18 where the centre heat exchange element 10 do not have this outer cylinder 50.

25 The centre heat exchange element 10' could have inner ribs 37 extending radially inwards from the core surface 21c as shown in Figure 39b or a smooth inner surface as shown in Figure 39a. The inner ribs 37 will increase the inner surface area of the core 21c and hence increase the heat transfer. This embodiment is particularly suitable for use as a terrestrial heat exchanger.

Figures 40- 46 shows a heat exchanger using the centre heat exchange elements 10` from Figure 39a-39b. The centre heat exchange element 10` with the outer cylindrical plate 50 cylindrical part forms a cylindrical part that could in both ends be connected to pipelines 102 by for instance a pipe fitting 101. This differs from the embodiment of Figure 36-38 where the centre heat exchange element 10 is arranged within the duct 41 and not forming part of the outer surface of the pipeline. The centre heat exchange element 10 do not have an outer cylinder fixedly attached to the fins 35, 36.

Figures 42-43 show the second plug 13 and a cap 14 in greater detail. The second plug 13 has arrangement for bleeding or aeration of the core 20, 21. The core 20, 21 is normally filled with a heating agent or coolant but there could also be air bubbles together with the coolant or heating agent inside the core 20, 21.

These bubbles could be removed from the core 20, 21 through a clearance between an opening 13b in the second plug 13 and the threaded rod that extends through the opening in the second plug as shown in Figure 42-43. To release the air it is possible to loosen the cap 14 that is screwed onto the threaded rod 27. This is shown in detail in Figure 12

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The heat exchanger 100 could be secured to the pipe fittings 101 in different ways as shown in Figures 45-46. In Figure 46 the first plug 22 and second plug 13 are arranged in mountings 42 that are fixed to the inner walls of the fittings 101.

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Figures 47-51 show another embodiment of the heat exchanger according to the invention, which is arranged within a duct 43. In this embodiment, the heat exchanger 2 comprises a centre heat exchange element 10 and a plurality of side heat exchange element 11 as described in figure 3-10. This arrangement is also suitable for heat exchanging liquids.

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In yet another embodiment of the heat exchanger according to the invention, there is arranged an electrical heating coil within the core of the heat exchange element 10, 11 to heat the fluid in the core 20, 21 instead of supplying warm fluid externally through pipes or tubes 12a, 12b, 12c as shown in the previous drawings. This is particularly useful in smaller scale as a heating element or
 5 where there is not possible to heat the fluid by an external heating source. This could be applied in system for heating gases or system for heating liquid as described in the embodiments above.

10 Figure 51 shows another example of use of the heat exchanger. The heat exchanger is in this embodiment arranged in connection with a fan or other type of blower 30 for blowing air through the heat exchanger, and hence blowing heated air into e.g. a building. This illustrates just an example of the use. There are other possibilities of use, all being an embodiment of the invention

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Based on the accompanying drawing and the description of the different parts, a functional explanation of the invention is described hereinafter.

A heating agent or coolant is supplied to the core 20, 21 from the supply source
 20 to the core 20, 21. The heating agent or coolant is supplied via the inlet pipe or tube 12a, through the opening 22a of the first plug 22 and through the pipe 26 so that the heating agent or coolant is led to the opposite end of the core 20, 21, i.e. towards the second plug 13. The heating agent or coolant that enters the core 20, 21 will push the heating agent or the coolant already present in the
 25 core 20, 21 towards the outlet opening 22b and it will flow out of the core 20, 21 towards another core 20, 21 or through the outlet pipe of tube 12c.

Optionally the heating agent of coolant could be warmed or cooled by a heating coil or cooling arrangement arranged within the core 20, 21.

30 The heating agent or coolant could be either a gas or a liquid. The inside of the core 20, 21 preferably have smooth walls to reduce friction.

In an optional embodiment, inner ribs 37 are formed on the inside of the core surface 20c or a removable inner core element 40. This can be done for instance by milling. The ribs 37 increase the surface area and thereby
5 transmission of heat from the heating fluid.

A fluid to be heated or cooled is conducted lengthwise of the ribs 30 through the heat exchange elements 10, 11 from a first or second end of the heating element towards the opposite end of the heating element 2, 100.

10

The fluid is heated or cooled by the transmission of energy through the surface of the core 20c, the ribs and the fins.

There is described both a transmission of heat from a heating fluid in the core to
15 a heated fluid throughout the description as well as a cooling process where a coolant is supplied to the core and a fluid to be heated is conducted along the ribs.

The present invention has been described with reference to preferred
20 embodiments and aspects thereof and related to the accompanying drawings for the sake of understanding only and it should be obvious to persons skilled in the art that the present invention includes all legitimate modifications within the ambit of what has been described hereinbefore and claimed in the attached claims.

25

CLAIMS

1.

A heat exchanger for transferring heat between two fluids with different
5 temperature, said heat exchanger comprises a first heat exchange element
(10, 11), said first heat exchange element (10, 11) having at least one core (20,
21) extending longitudinally through the heat exchange element (10, 11), said at
least one core (20, 21) being configured to contain a first fluid, said first heat
exchange element (10, 11) having ribs (30) extending continuously substantially
10 in parallel with the at least one core (20, 21) along the whole length of said core
(20, 21), said ribs (30) extending radially outwardly from the core (20, 21) and
being exposed to contact with a second fluid, flowing along said ribs (30)
characterised in that said each rib (30, 31) is divided into at least
two radially extending fins (33, 34, 35, 36) at a radial distance from the core (20,
15 21), said each fin extends to a proximity of an outer casing surrounding said first
heat exchanger element (10, 11) or to a proximity of the fins of a second heat
exchanger element (11), said second heat exchanger element (11) being
arranged adjacent the first heat exchanger element (10, 11) thereby
transferring heat from the first fluid to the second fluid evenly throughout the
20 heat exchanger.

2.

A heat exchanger according to claim 1, wherein an inlet port (22a) and an outlet
port (22b) are coupled to said core (20,21) at the same end opening of the core
25 (20, 21).

3.

A heat exchanger according to any of the claim 1-2, wherein the heat exchange
element (10, 11) is made by extrusion.

30

4.

A heat exchanger according to any of the claims 1-3, wherein the ribs (30, 31)
have a smooth surface.

5.

A heat exchanger according to any of the claims 1-4, wherein the heat exchange element (10, 11) is made of a metal.

5

6.

A heat exchanger according to any of the claim 1-5, wherein the heat exchanger comprises a plurality of heat exchanger elements (10, 11), arranged adjacent each other.

10

7.

A heat exchanger according to any of the claim 1-6, wherein the heat exchanger comprises a centre heat exchanger element (10) and side heat exchange elements (11), said side heat exchange elements (11) are arranged surrounding the outer periphery of the centre element (10).

15

8.

A heat exchanger according to any of the claim 1-7 wherein the heat exchanger comprises at least one heat exchanger element (10, 11) arranged within a casing (16).

20

9.

A heat exchanger according to any of the preceding claims, wherein the inner surface of at least one core (20, 21) having ribs (37) extending longitudinally and radially with the core (20, 21).

25

30 10.

A heat exchanger according to any of the preceding claims, wherein the first fluid contained in the at least one core (20, 21) is heated by an external heating source.

30

35 11.

A heat exchanger according to any of the preceding claims, wherein a heating

coil is arranged within the at least one core (20, 21) to heat the first fluid conducted in the at least one core (20, 21).

5 12.

A heat exchanger according to any one of claim 1-11, wherein the heat exchanger element (10, 11) having a plurality of cores (20, 21) integrated in one heat exchange element (10, 11).

10

13.

A heat exchanger according to claim 12, wherein the plurality of ribs (30) are integrated with the cores (20, 21).

15

Patentkrav

1.

Varmeveksler for overføring av varme mellom to fluider med forskjellig
 5 temperatur, nevnte varmeveksler omfatter et første varmevekslerelement (10, 11), nevnte første varmevekslerelement (10, 11) har minst en kjerne (20,21) som strekker seg langsgående langs varmevekslerelementet (10,11), nevnte minst ene kjerne (20, 21) er tilpasset til å romme en første fluid, nevnte første varmevekslerelement (10,11) har ribber (30) som strekker seg kontinuerlig i
 10 hovedsak parallell med den minst ene kjernen (20,21) langs hele lengden av nevnte kjerne (20, 21), nevnte ribber (30) strekker seg radielt utover fra kjernen (20, 21) og er utsatt for kontakt med et andre fluid som strømmer langs nevnte ribber (30) k a r a k t e r i s e r t v e d at hver nevnte ribbe (30, 31) er delt i minst to finner (33, 34, 35,36) som strekker seg radielt utover i
 15 en radiell avstand fra kjernen (20, 21), nevnte hver finne strekker seg til en nærhet av en ytre kappe som omslutter nevnte første varmevekslerelement (10, 11) eller til en nærhet av finnene til et andre varmevekslerelement (11), nevnte andre varmevekslerelement (11) er anordnet tilliggende det første varmevekslerelementet (10, 11) for derved å overføre varme jevnt fra det første
 20 fluidet til det andre fluidet gjennom hele varmeveksleren.

2.

En varmeveksler ifølge krav 1, hvori en innløpsport (22a) og en utløpsport (22b) er koblet til nevnte kjerne (20, 21) på samme endeåpning av kjernen (20, 21).

25

3.

En varmeveksler ifølge et av kravene 1-2, hvori varmevekslerelementet (10, 11) er laget ved ekstrudering.

30

4.

En varmeveksler ifølge et av kravene 1-3, hvori ribbene (30, 31) har en glatt overflate.

5 5.

En varmeveksler ifølge et av kravene 1-4, hvori varmevekslerelementet (10, 11) er laget av metall.

6.

10 En varmeveksler ifølge et av kravene 1-5, hvori varmevekslerelementet omfatter et flertall av varmevekslerelement (10, 11) anordnet tilliggende hverandre.

7.

15 En varmeveksler ifølge et av kravene 1-6, hvori varmeveksleren omfatter et senter varmevekslerelement (10) og side varmeveksler-elementer (11), nevnte side varmevekslerelementer (11) er anordnet omgivende den ytre periferien av senter elementet (10).

20 8.

En varmeveksler ifølge et av kravene 1-7, hvori varmeveksleren omfatter minst et varmevekslerelement (10,11) anordnet på innsiden av en kappe (16).

9.

25 En varmeveksler ifølge et av de foregående kravene, hvori den indre overflaten

av minst et kjerne (20,21) har ribber (37) som strekker seg langsgående og radielt med kjernen (20, 21).

10.

- 5 En varmeveksler ifølge et av de foregående kravene, hvori det første fluidet som er inneholdende i den minst ene kjernen (20,21) er varmet av en ekstern varmekilde.

11.

- 10 En varmeveksler ifølge et av de foreliggende kravene, hvori en varmespiral er anordnet innvendig i den minst ene kjernen (20,21) for å varme det første fluidet som føres i den minst ene kjernen (20,21).

12.

- 15 En varmeveksler ifølge et av kravene 1-11, hvori varmevekslerelementet (10, 11) har et flertall av kjerner (20, 21) integrert i varmevekslerelementet (10, 11).

13.

- 20 En varmeveksler ifølge krav 12, hvori flertallet av ribbene (30) er integrert med kjernene (20, 21).

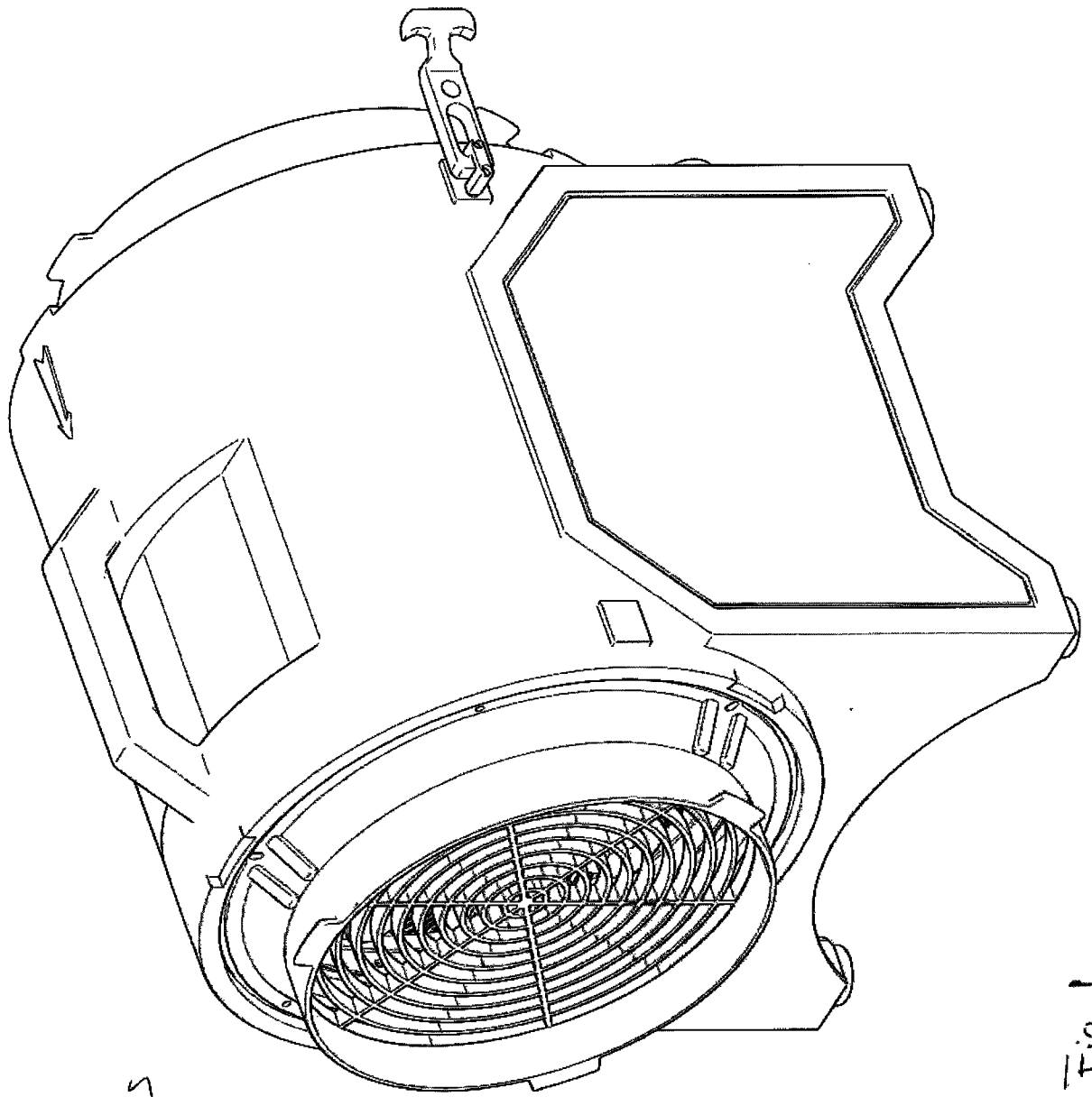


Fig. 1.

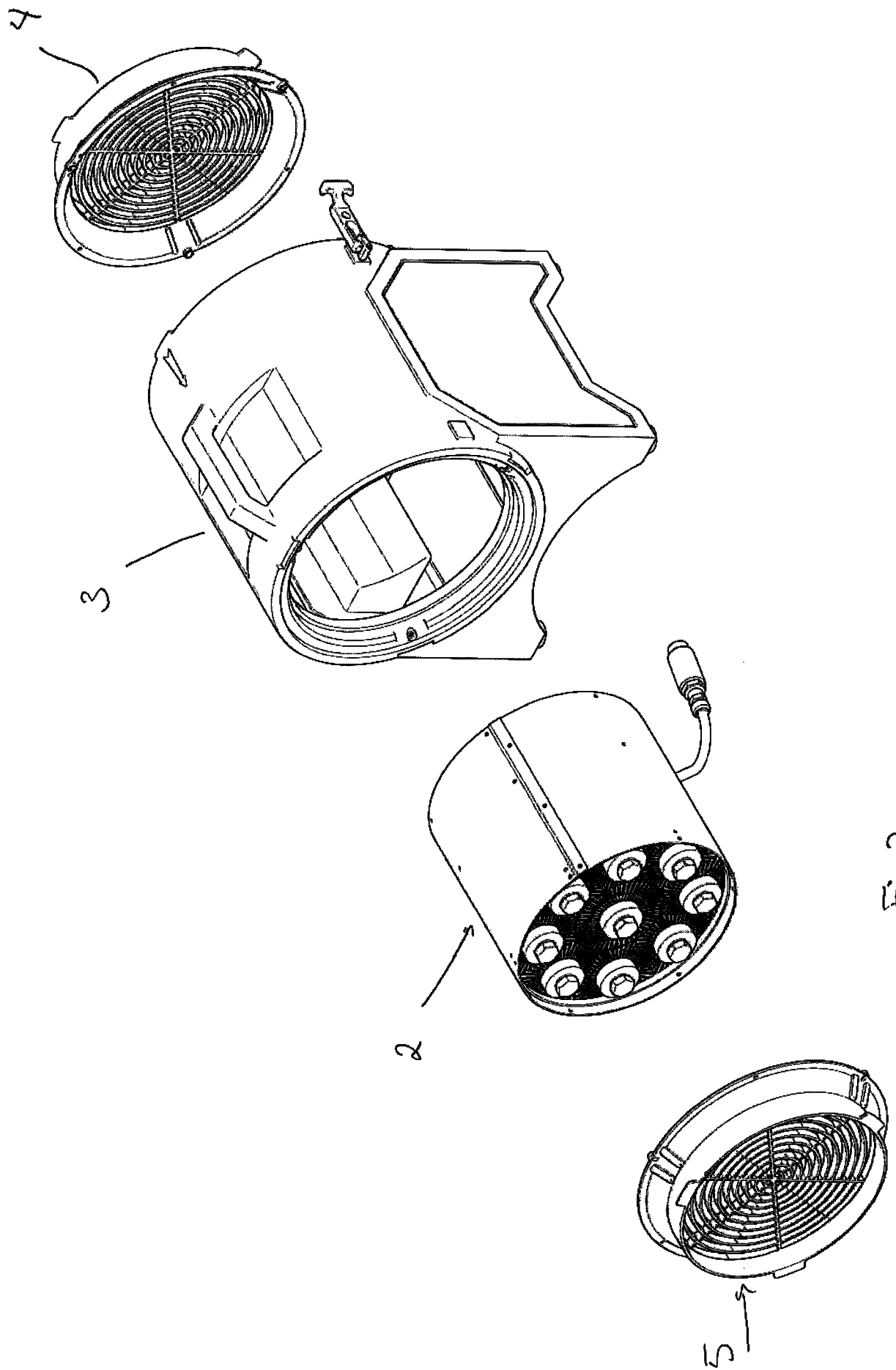


Fig 2

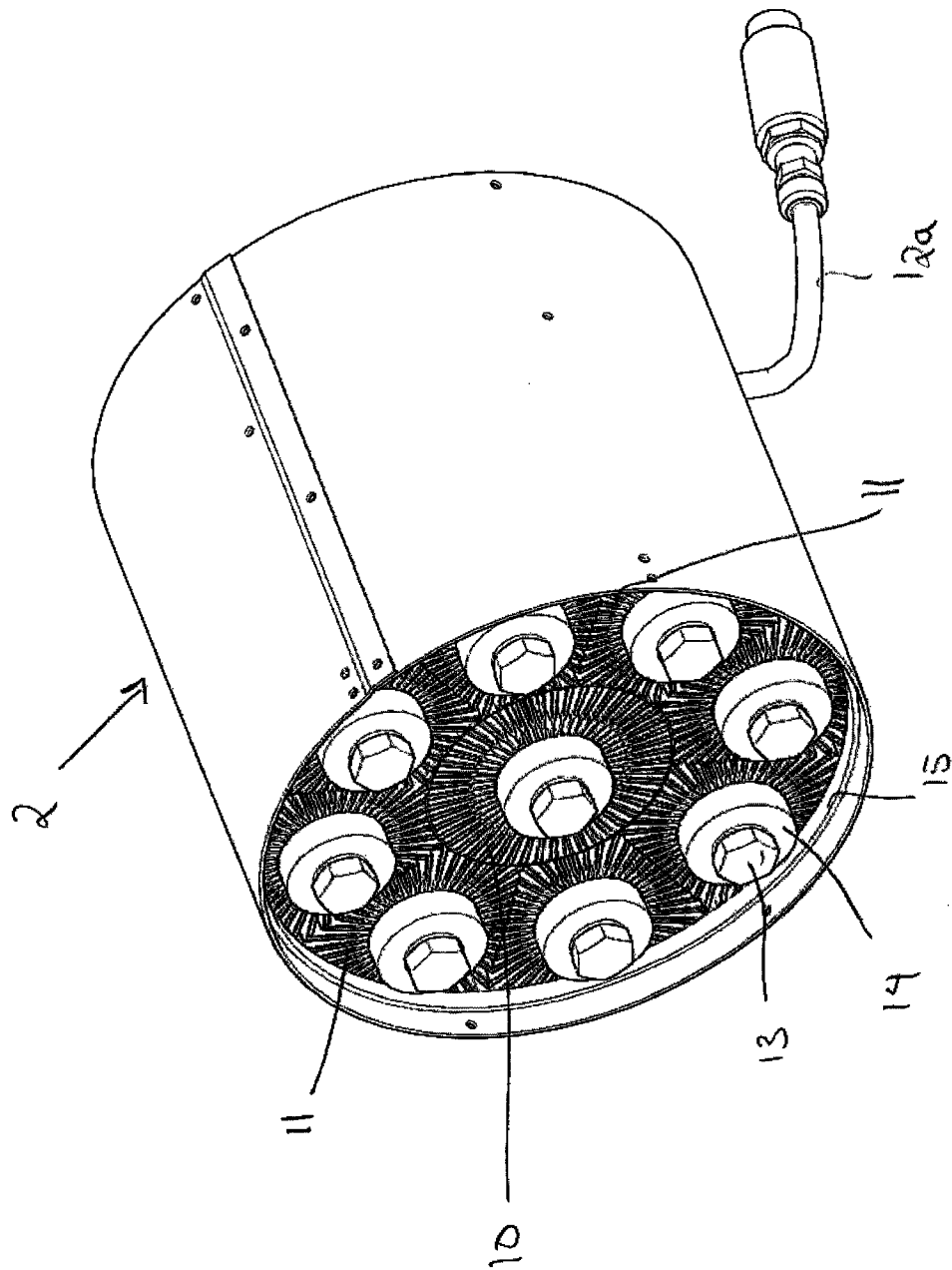


Fig 3.

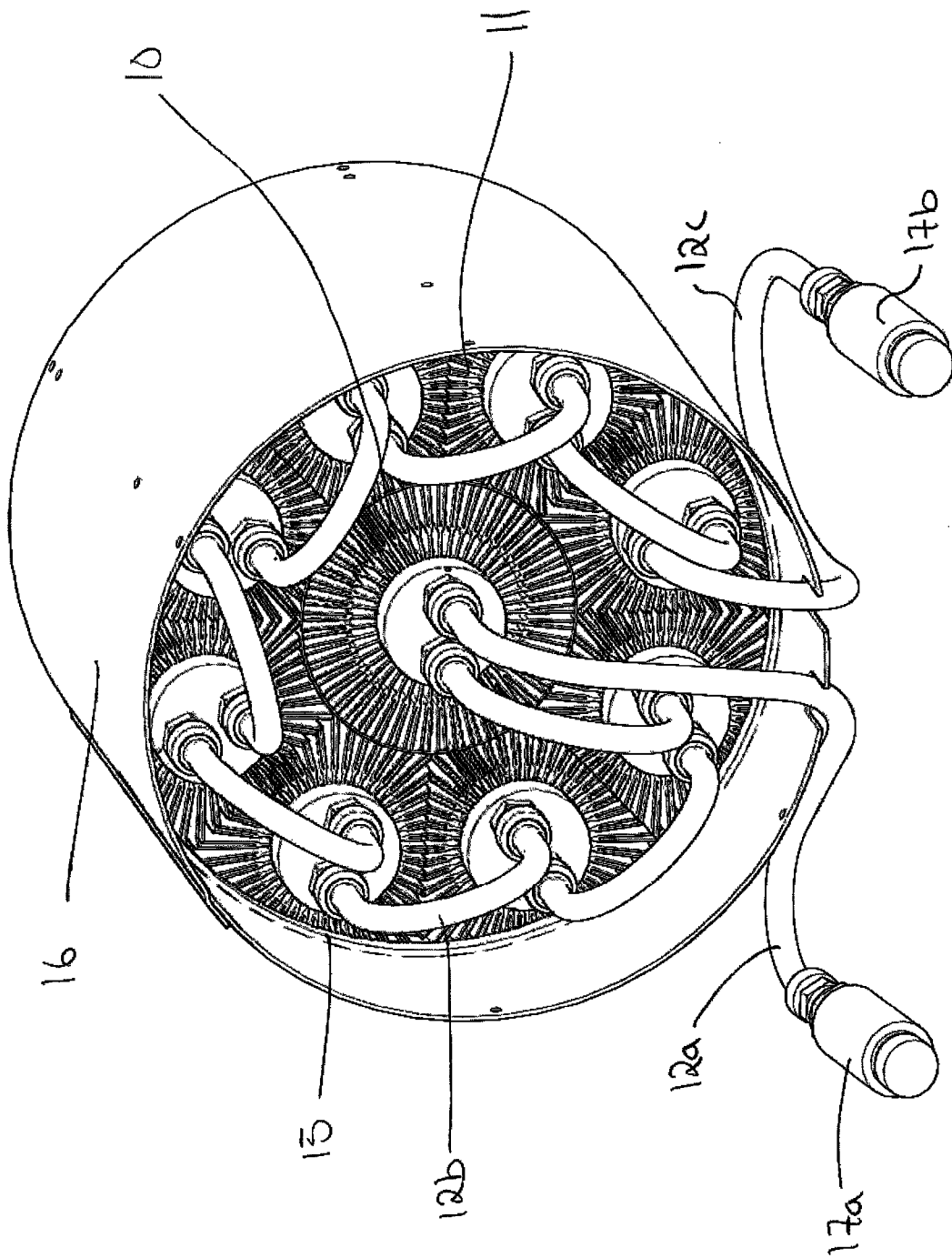
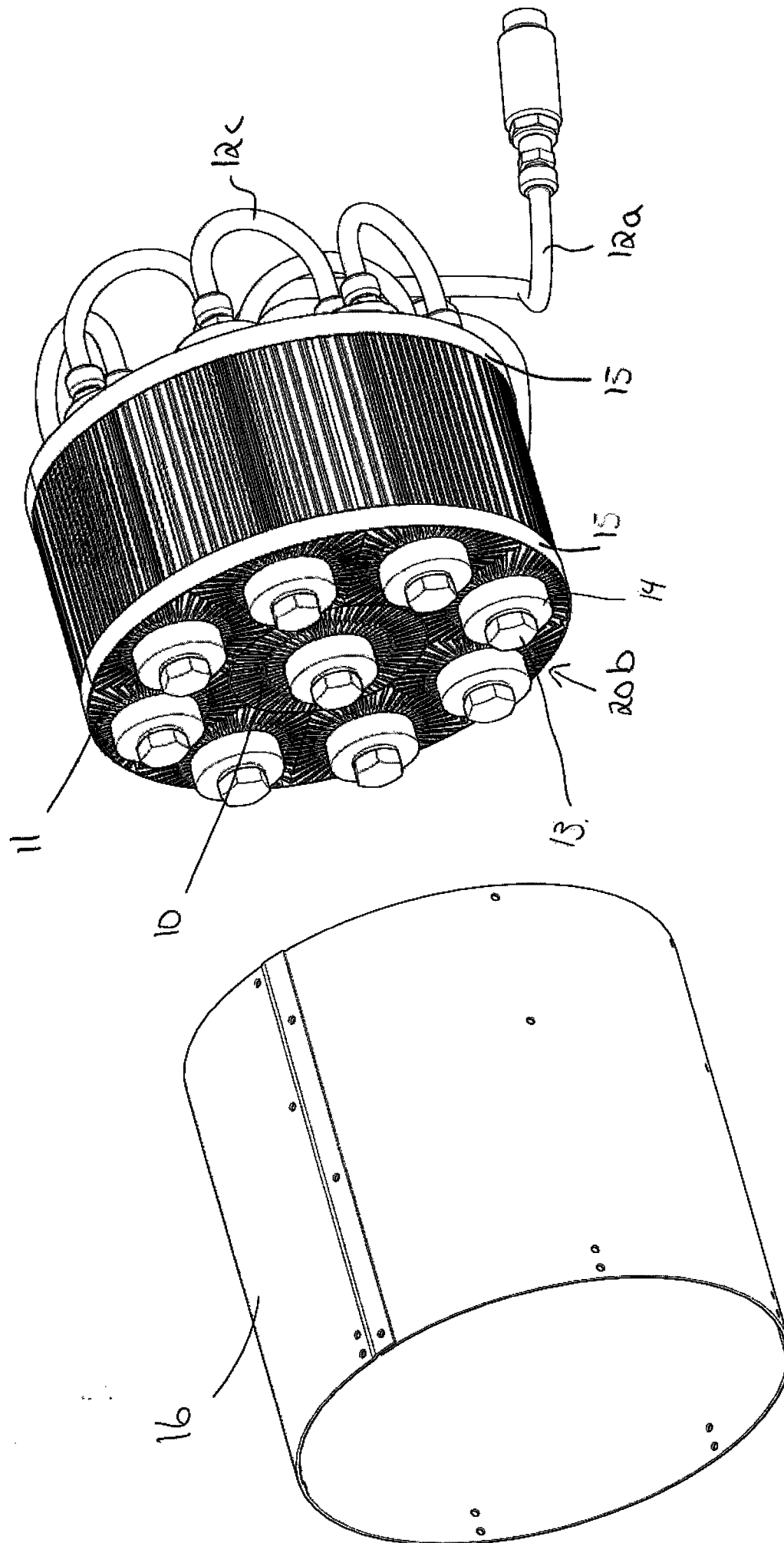


Fig. 4



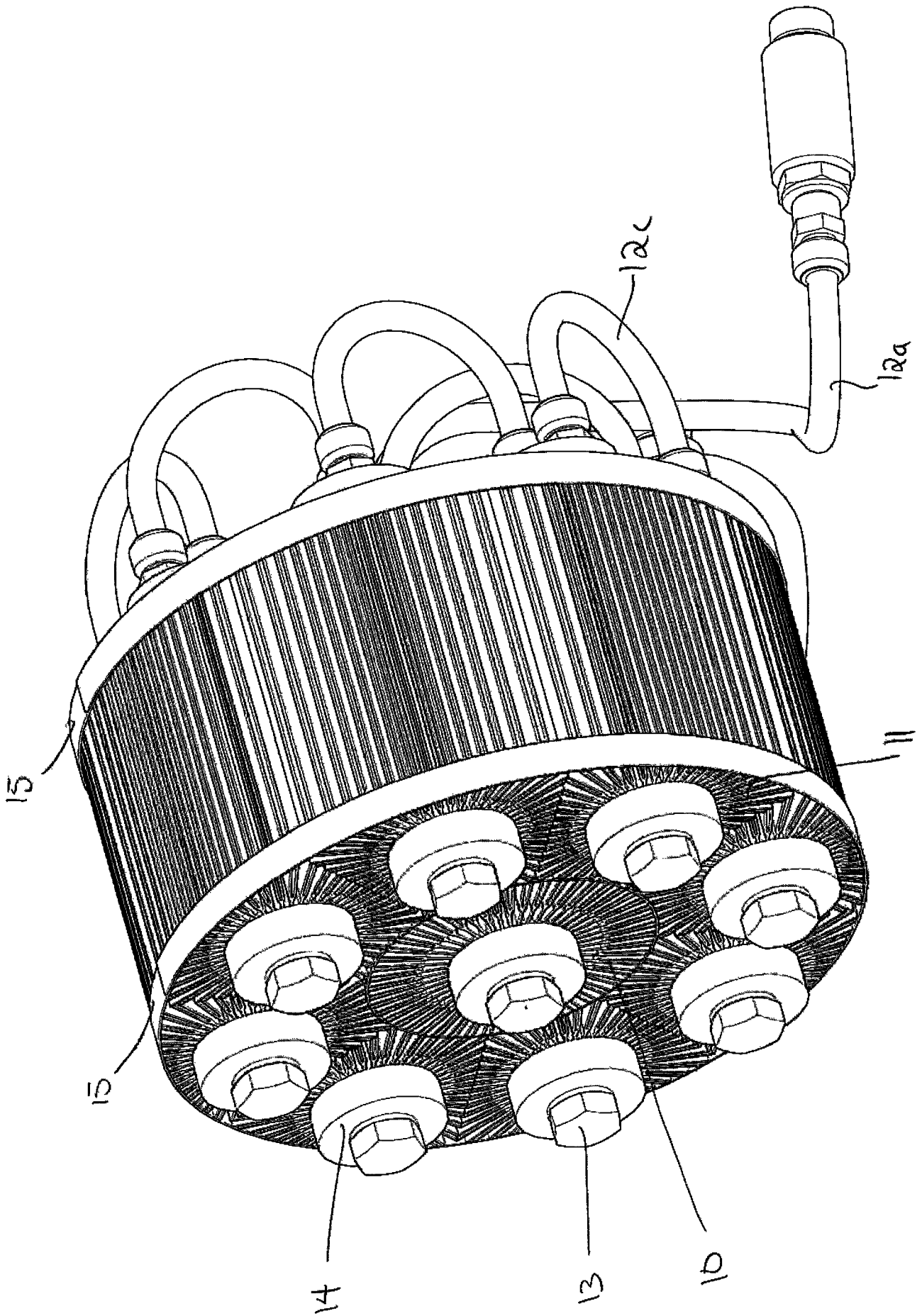
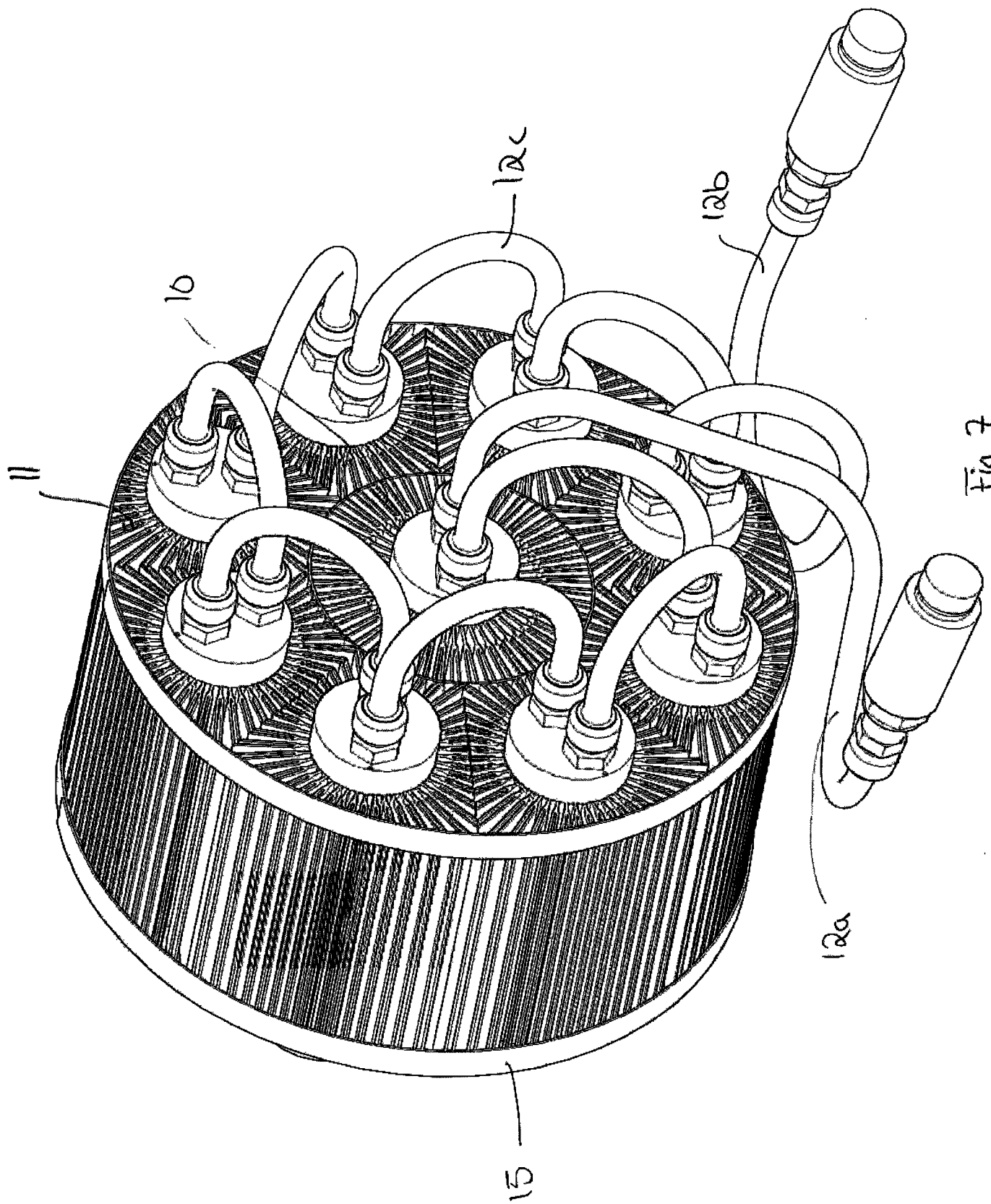


Fig 6



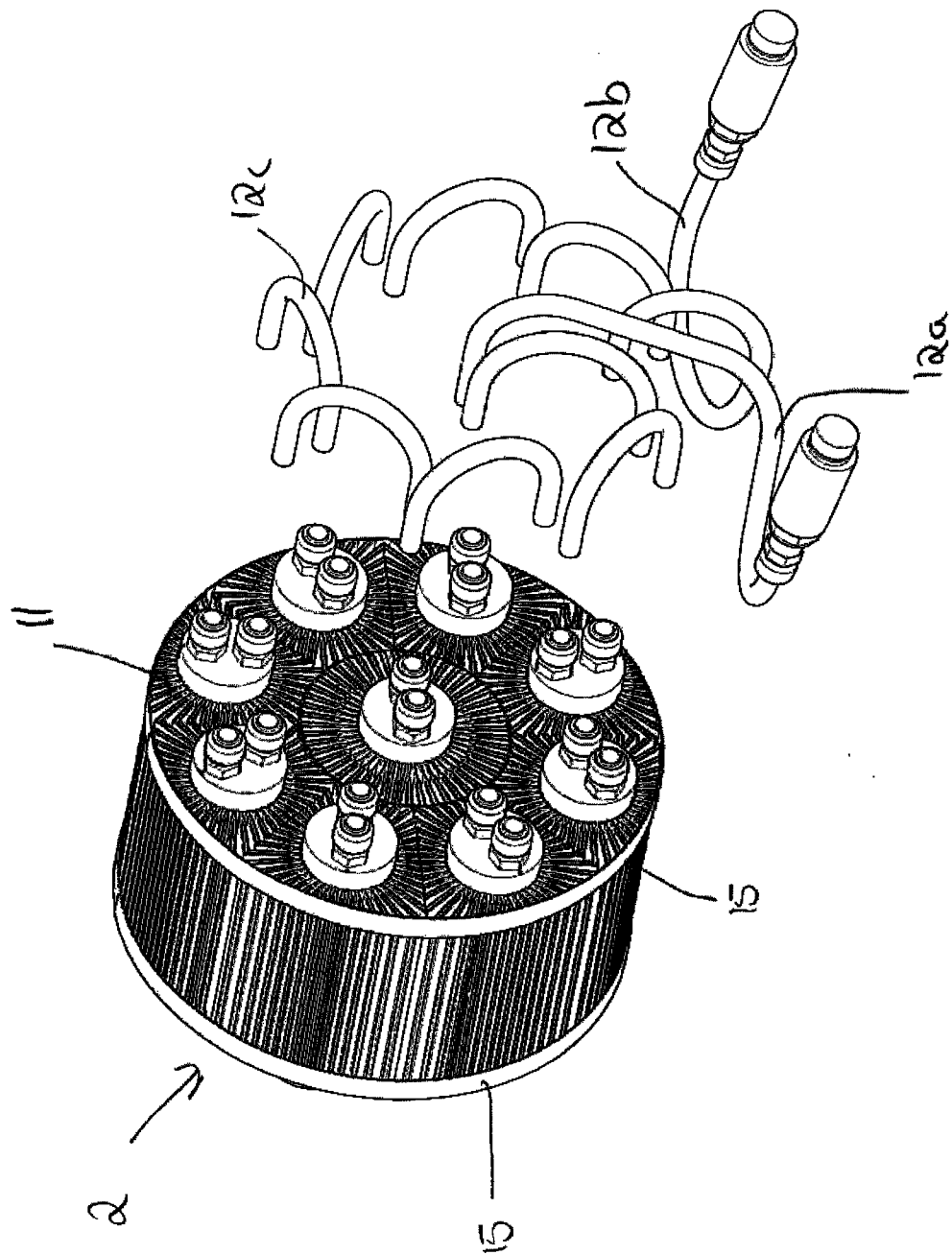


Fig. 8.

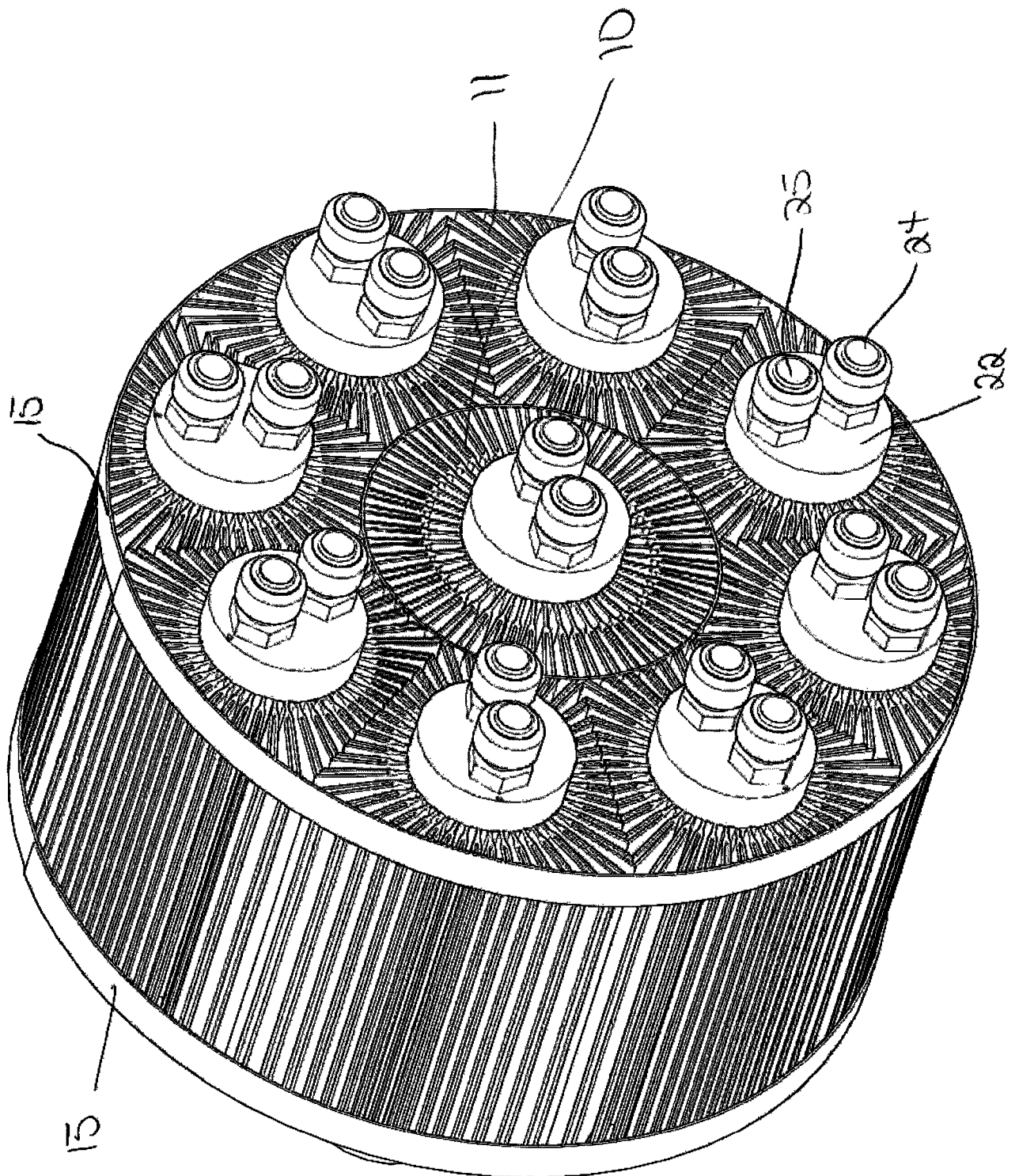


Fig. 9

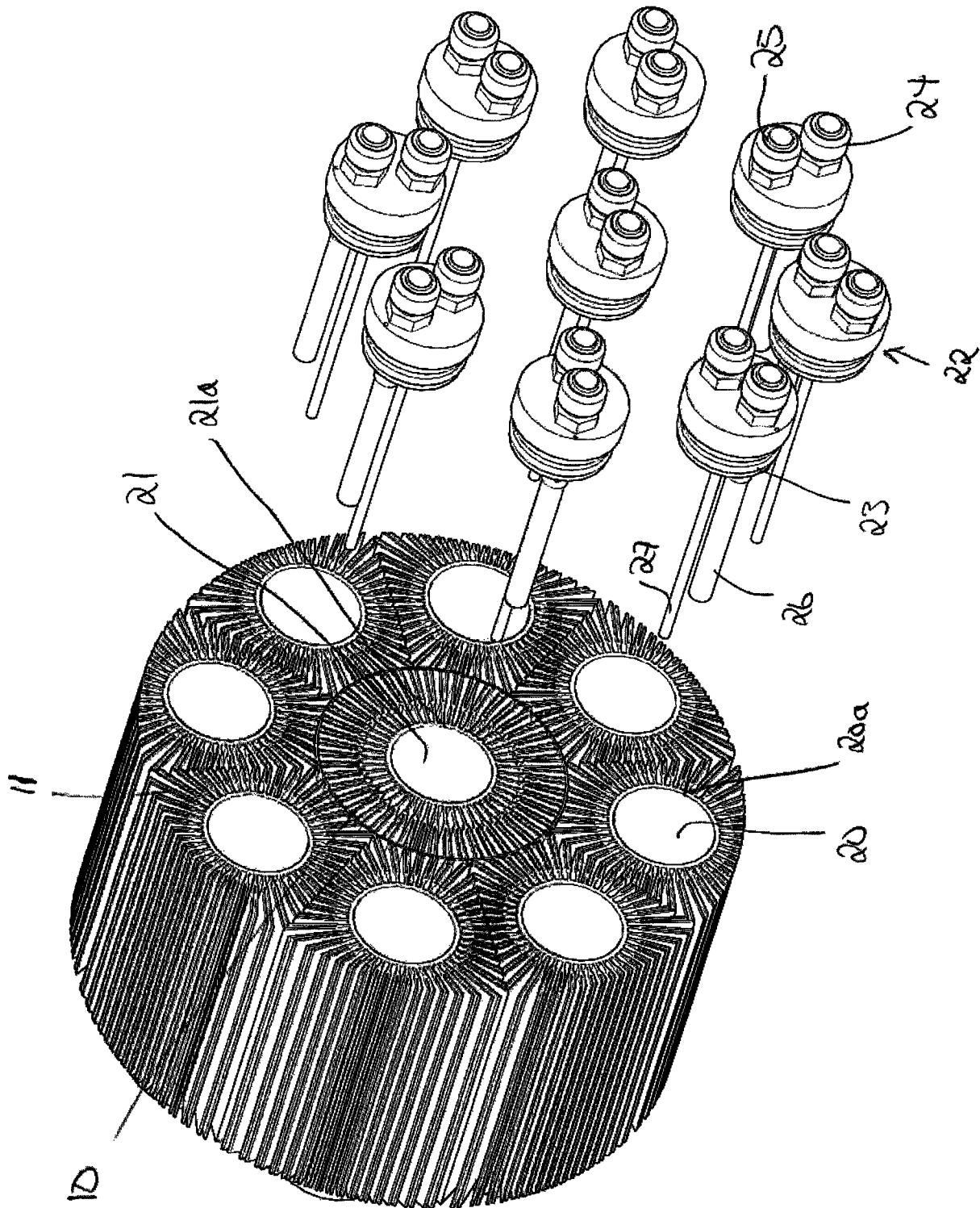


Fig 1b

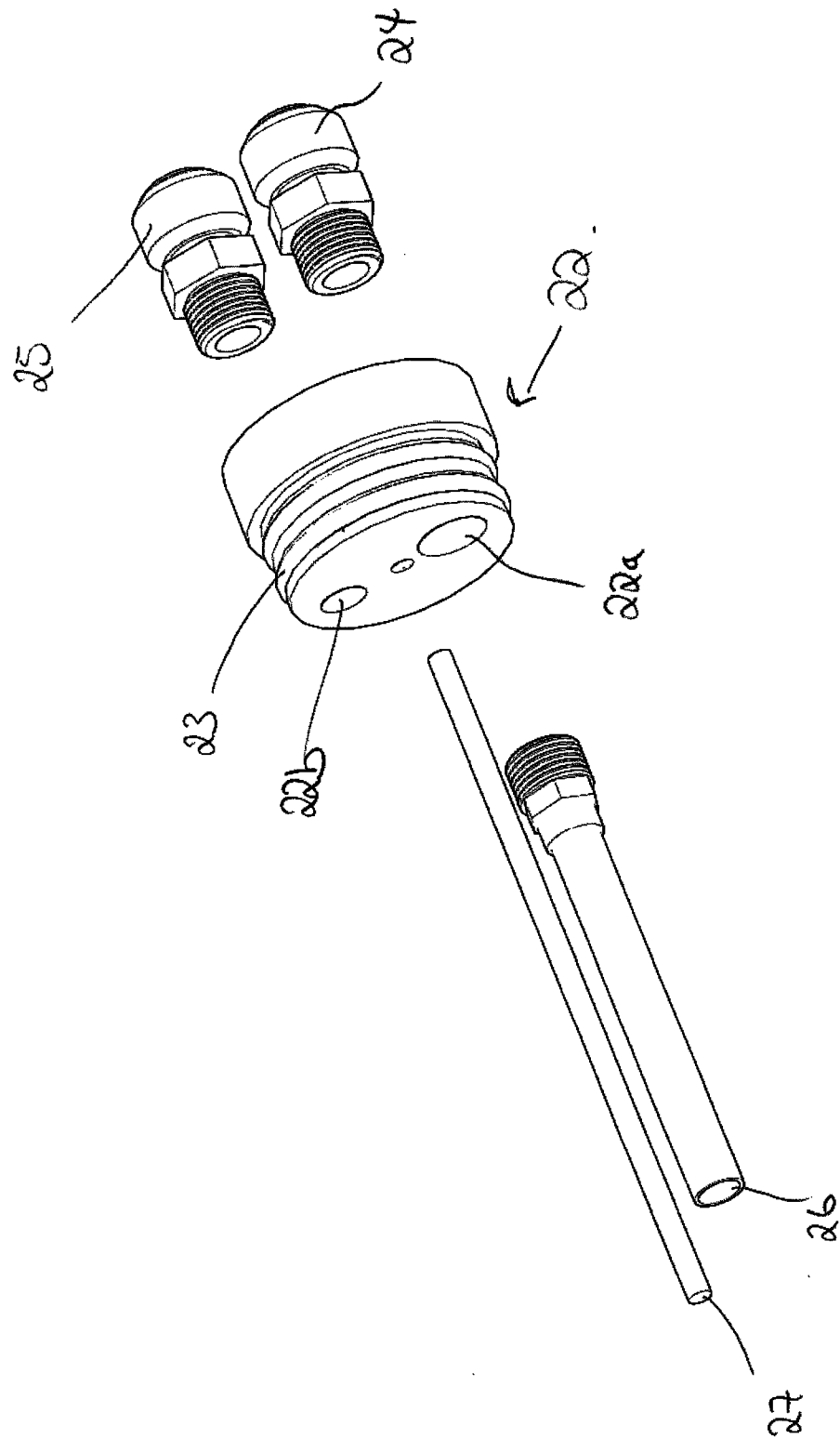


Fig. 11

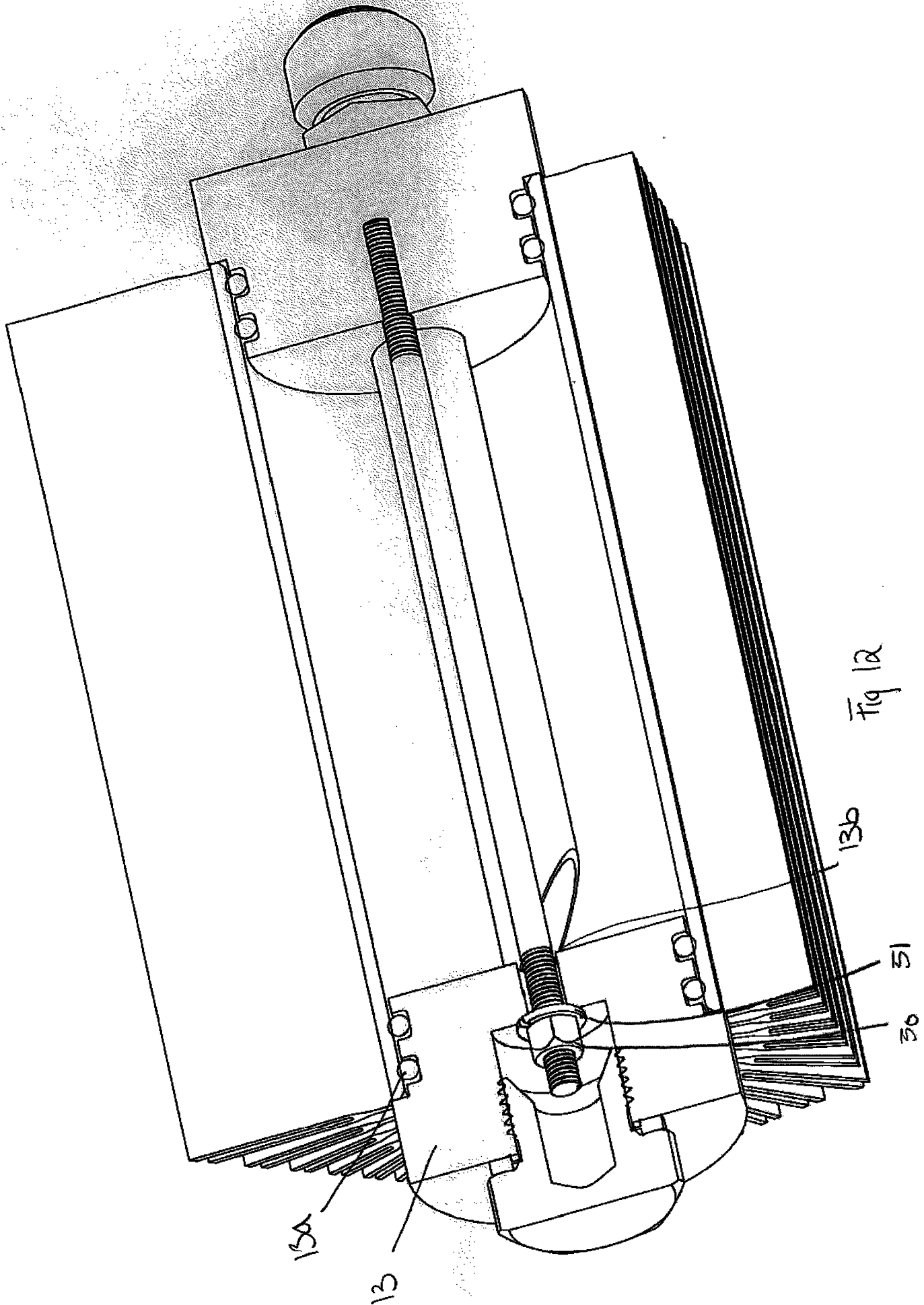




Fig 13

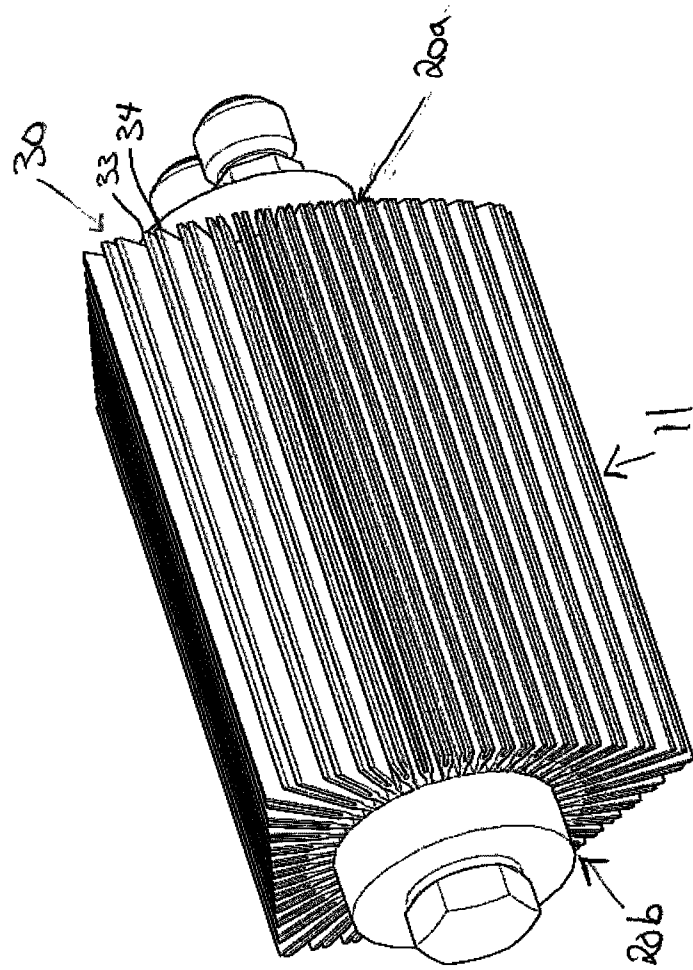


Fig 14

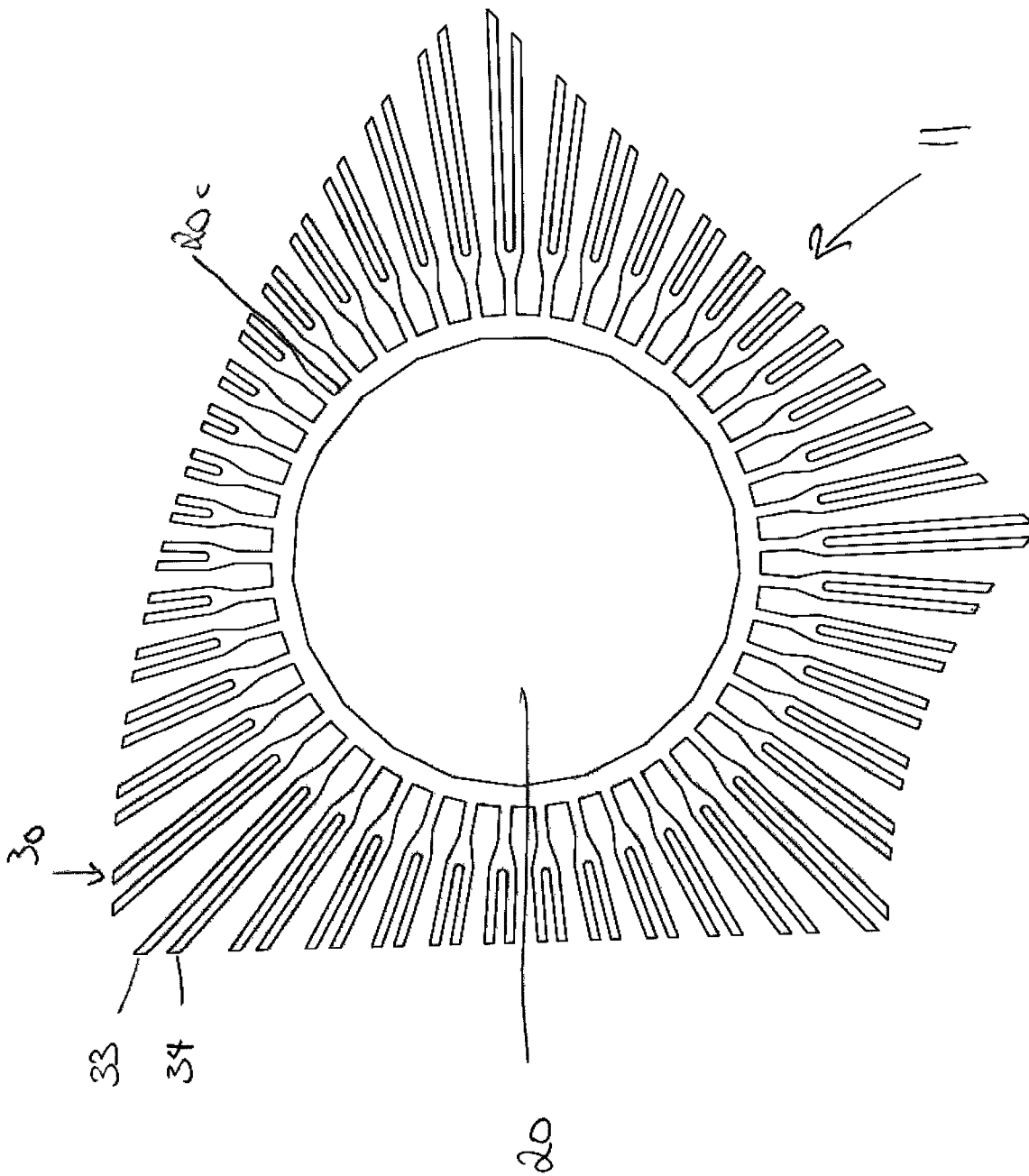


Fig 15

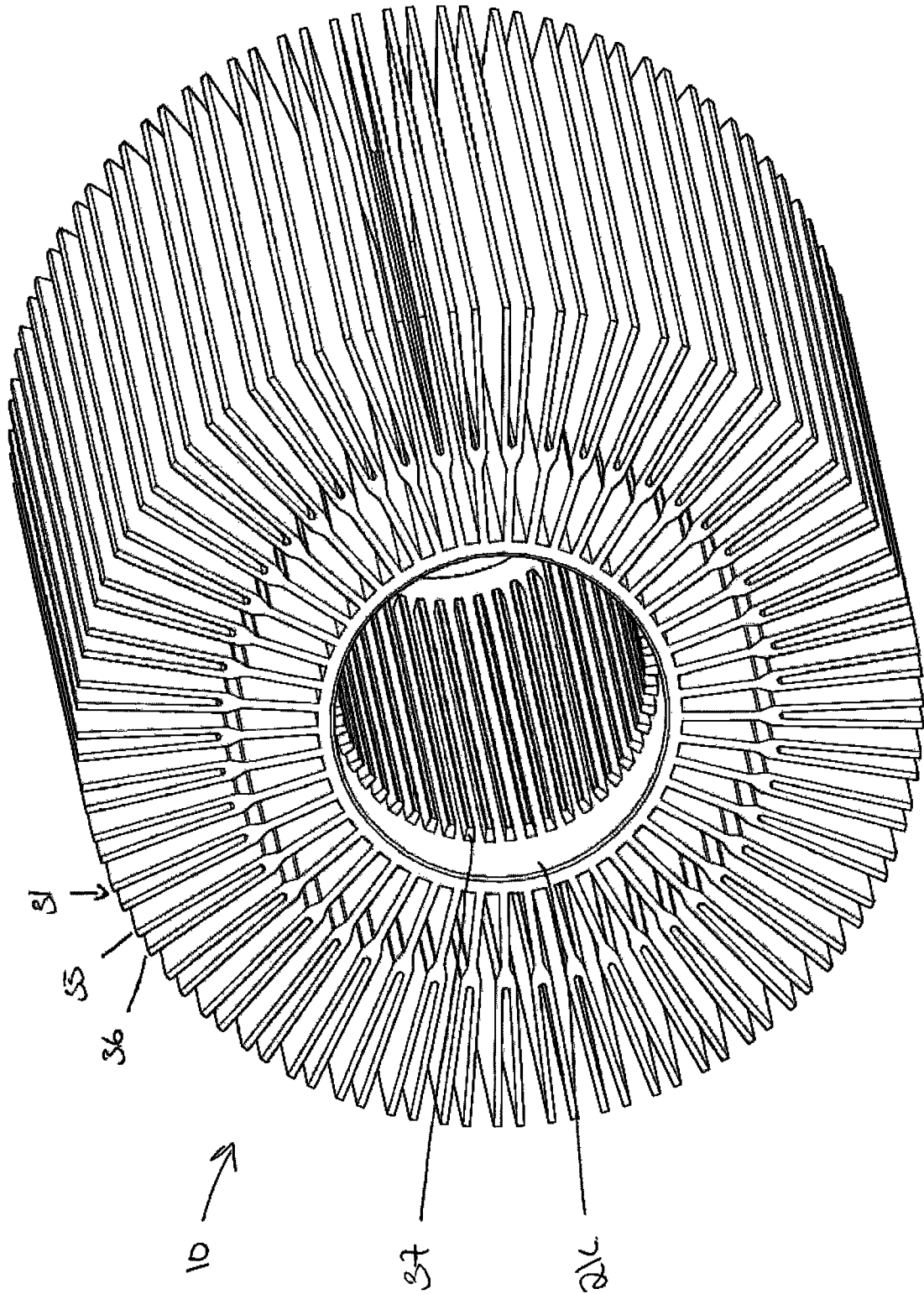


Fig 16.

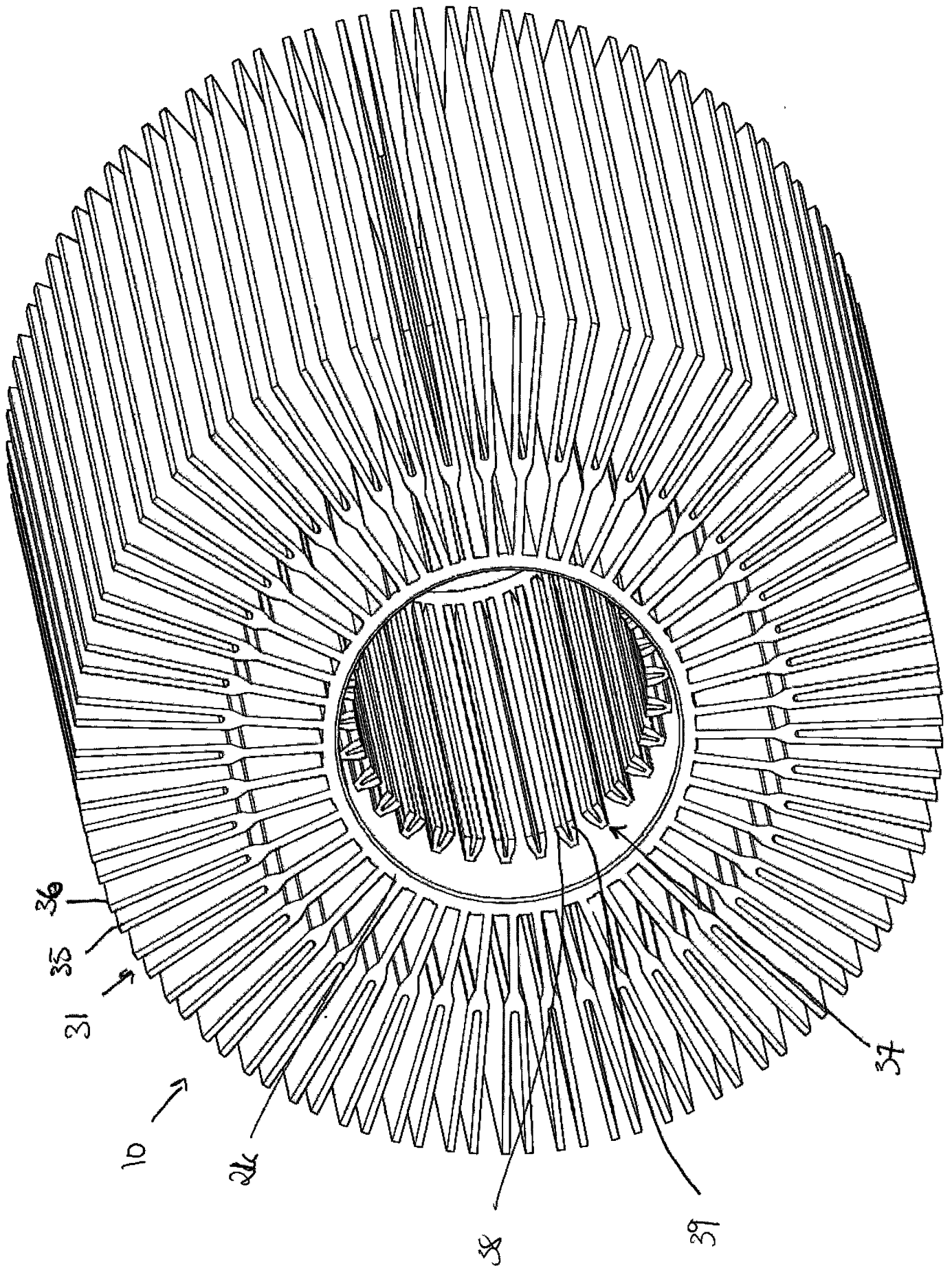


Fig 17

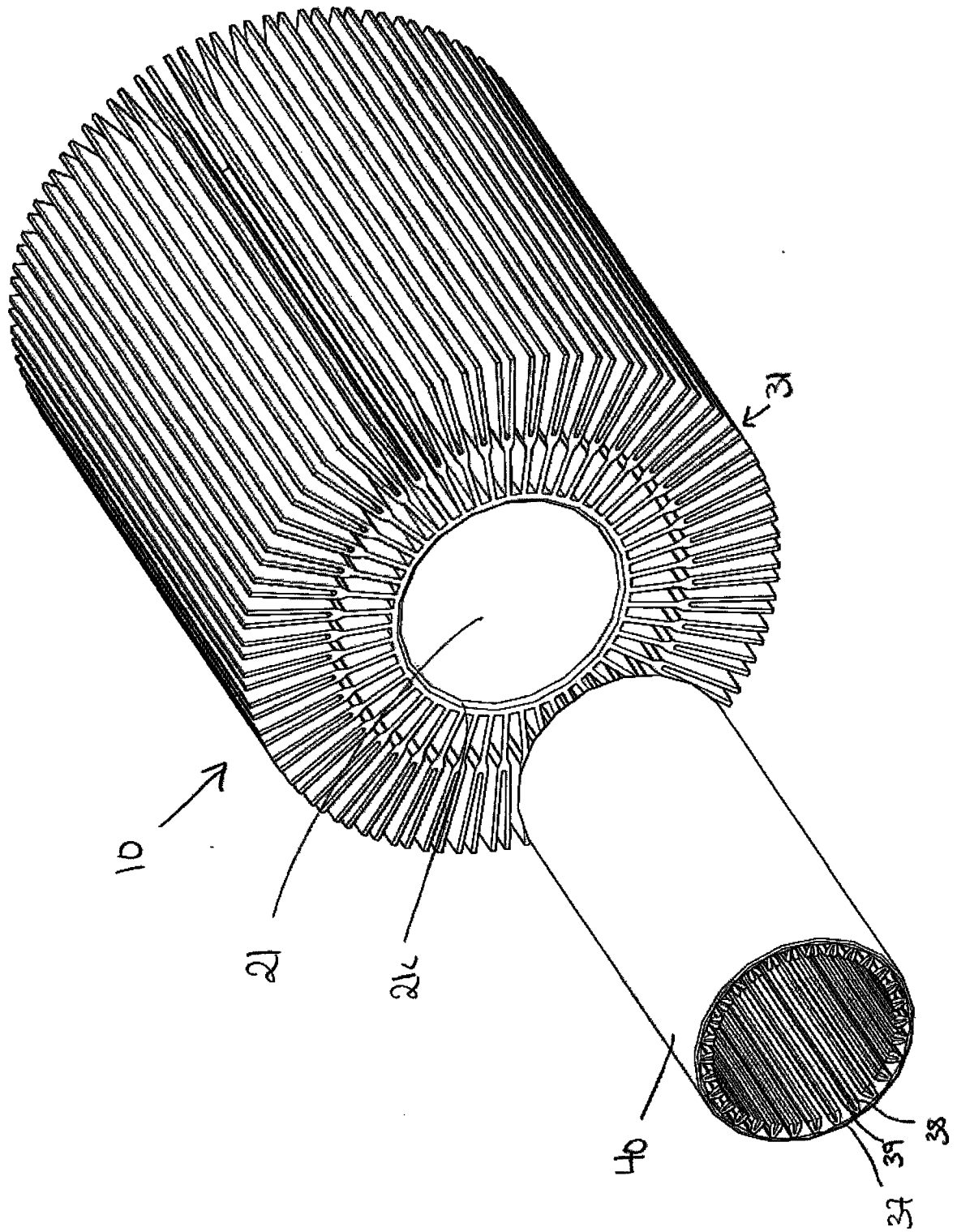


Fig 18

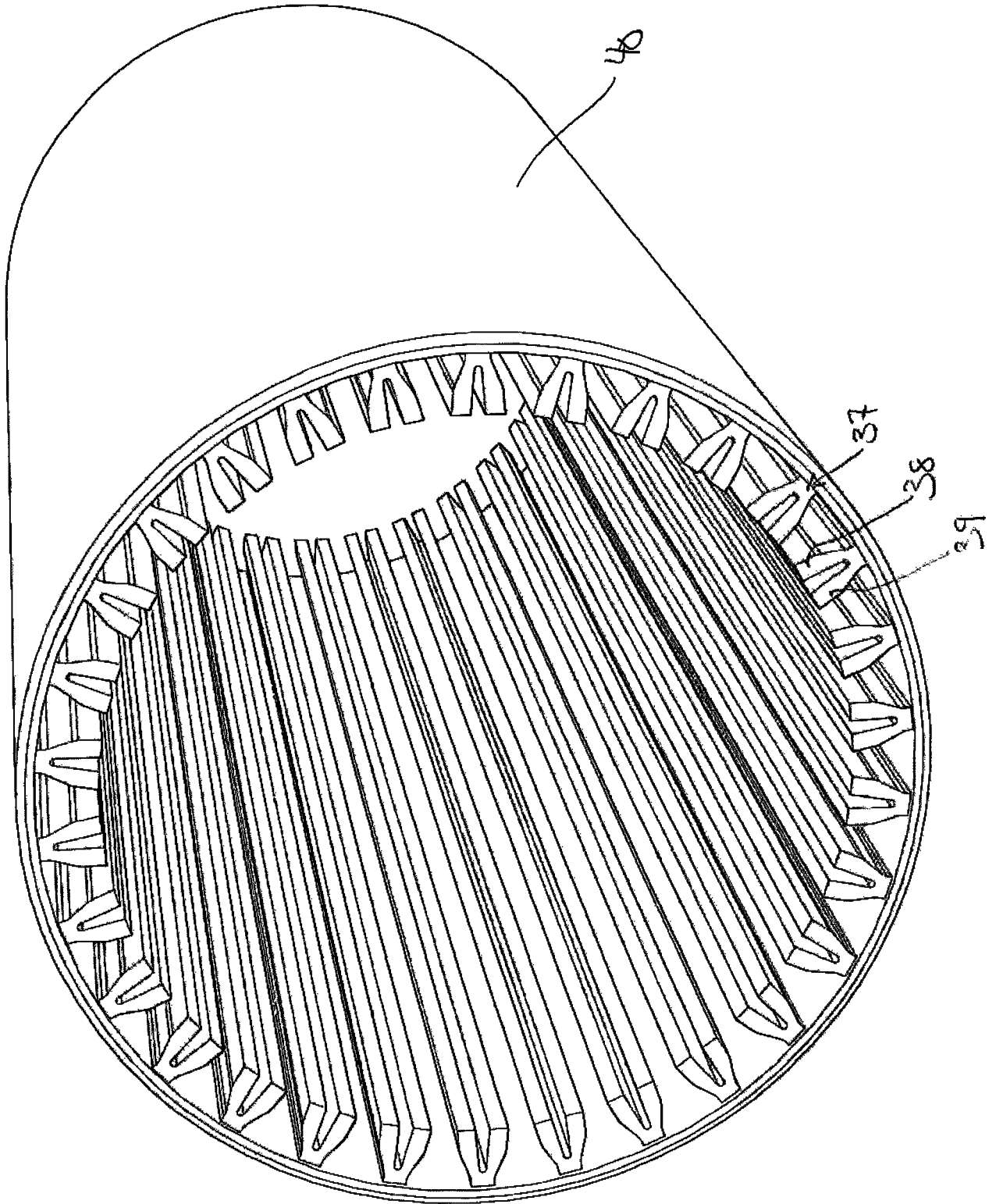


Fig 19

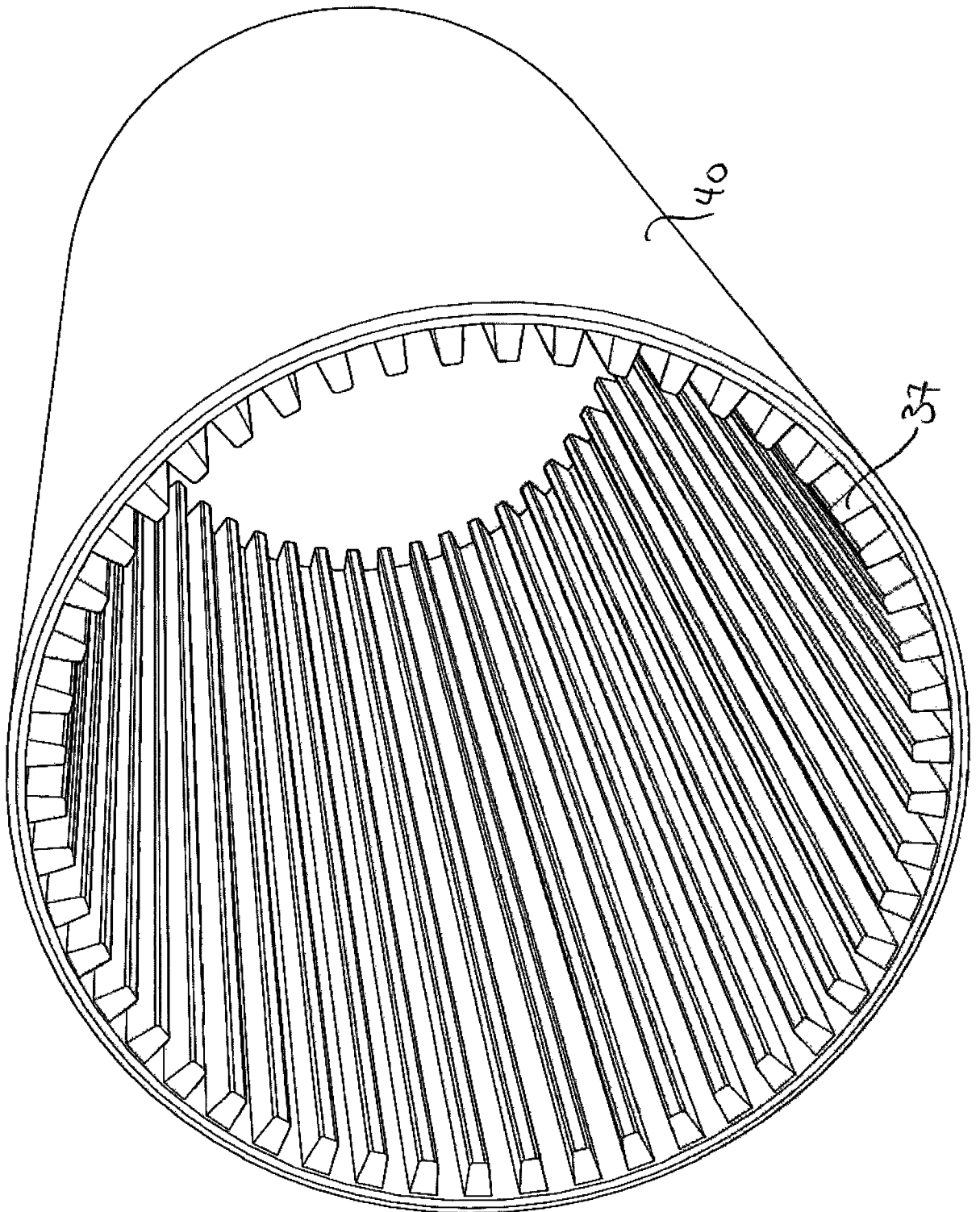


Fig 20

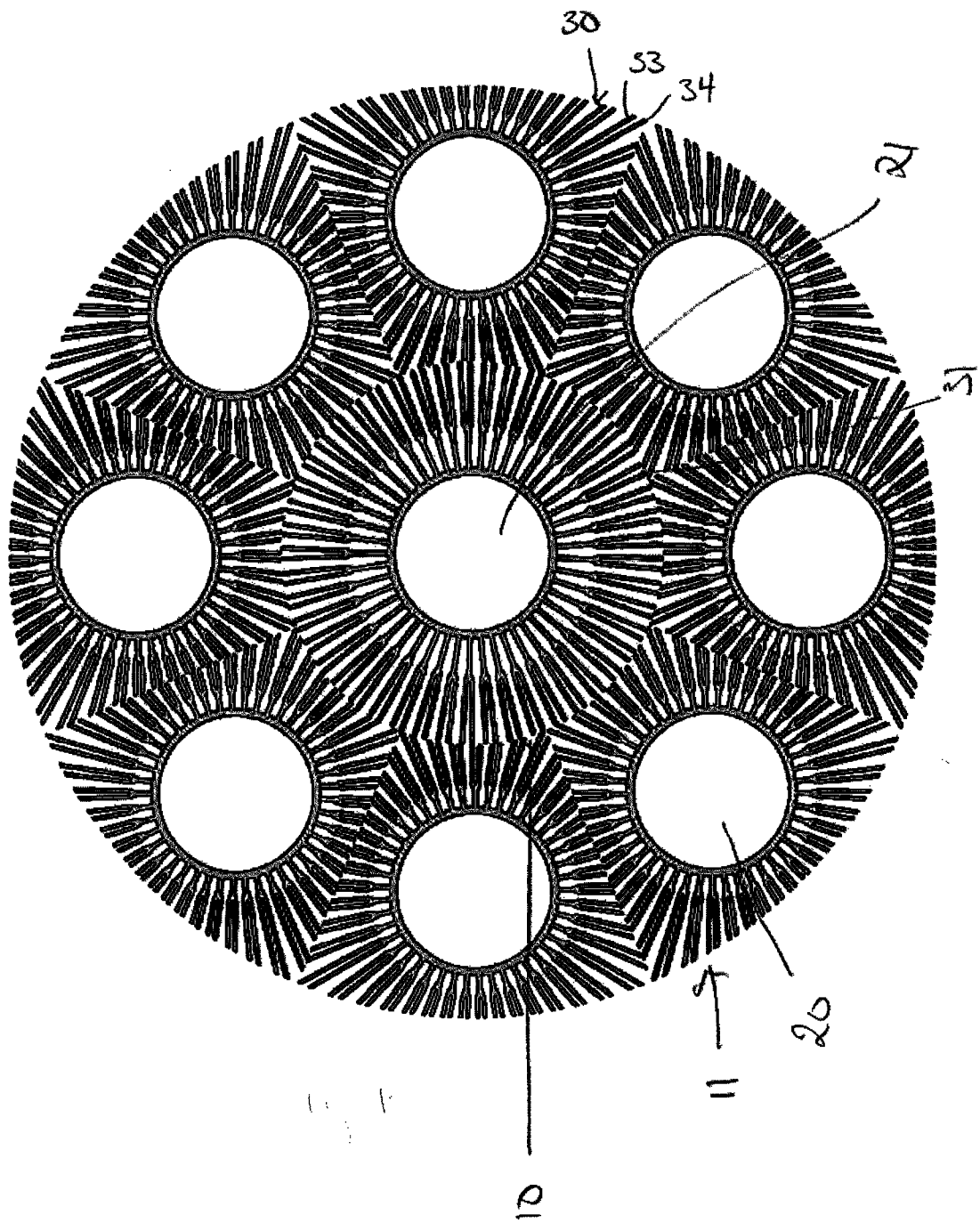


Fig 21



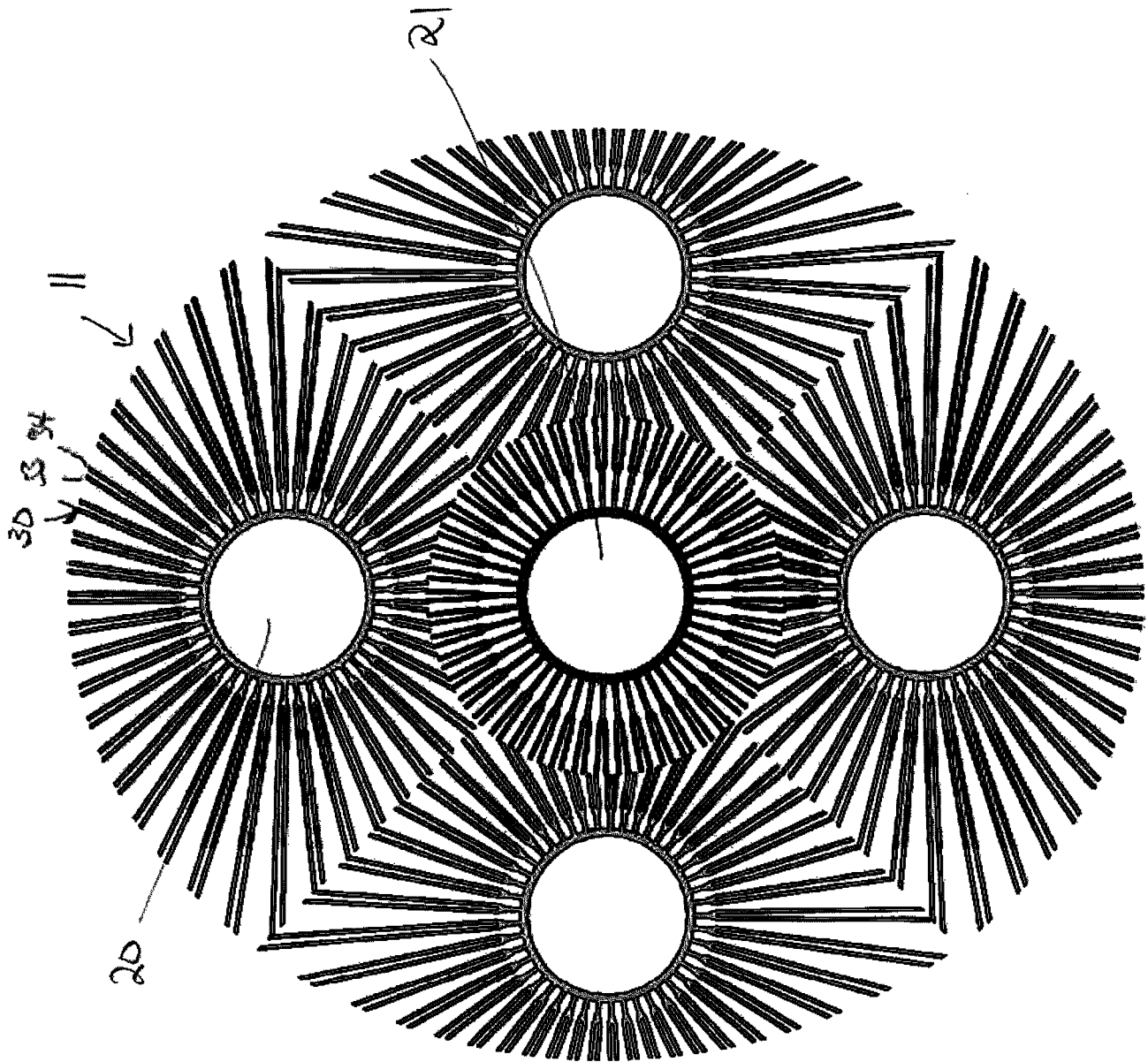


Fig 22



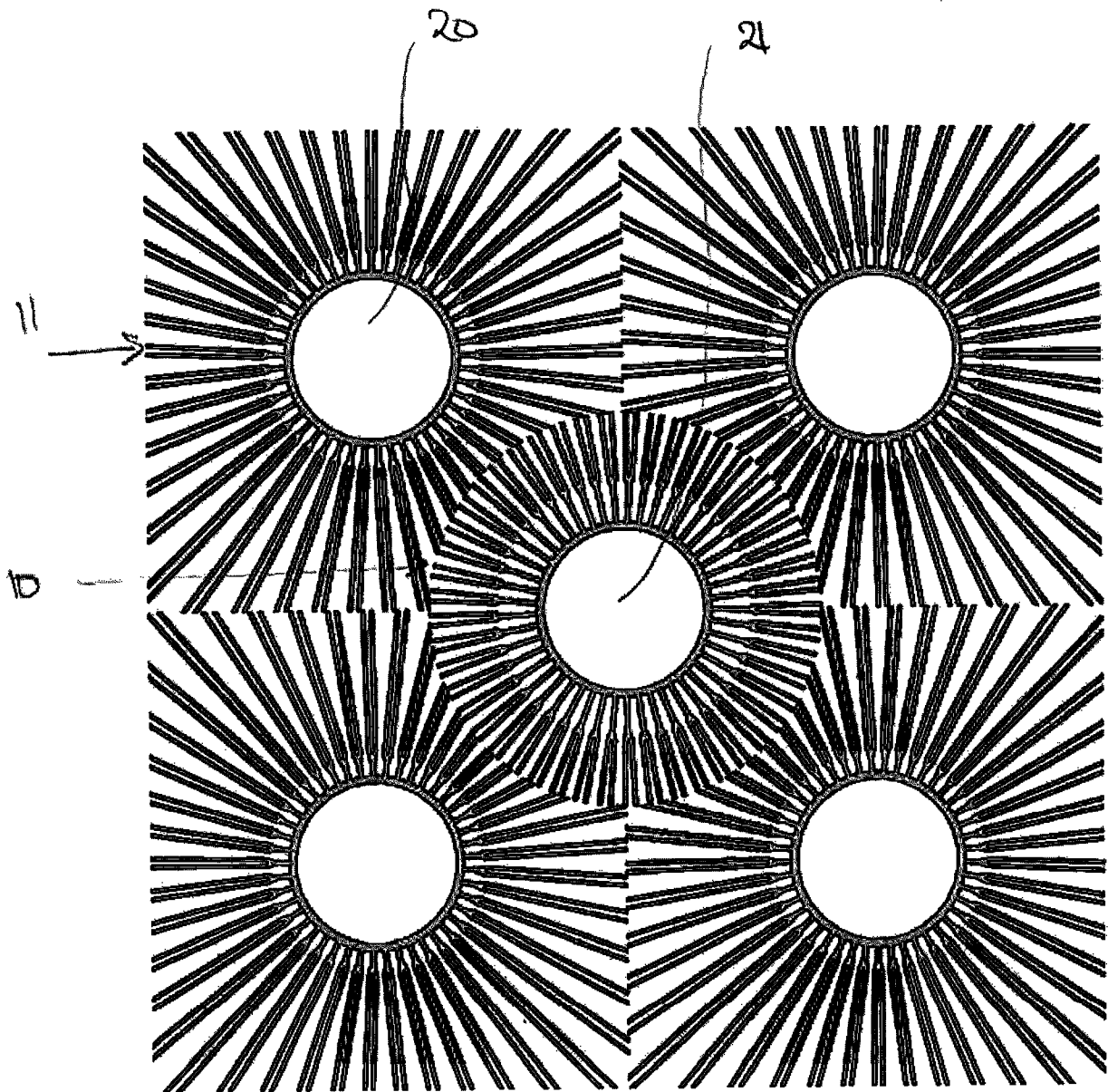


Fig. 23

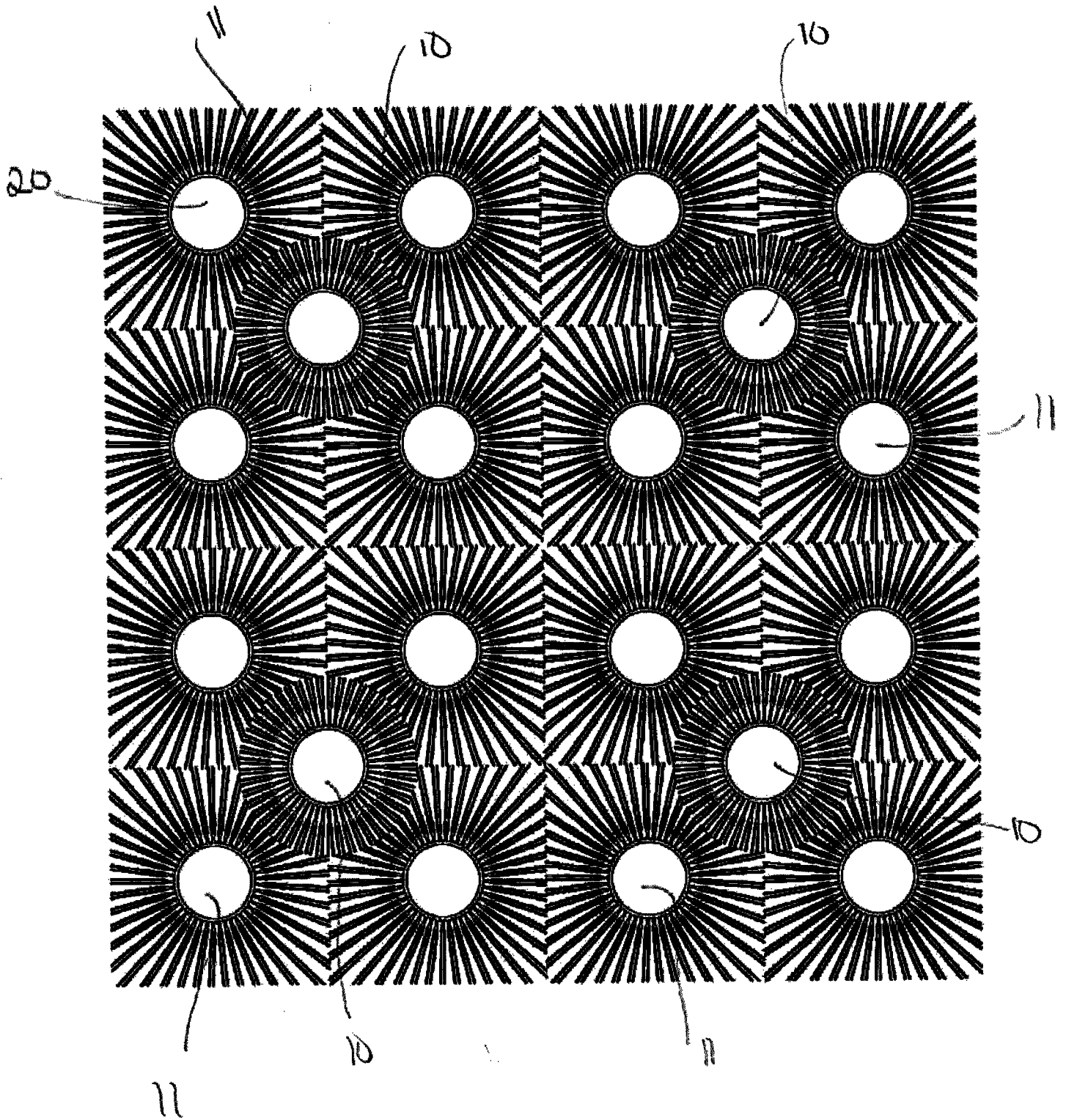


Fig. 24



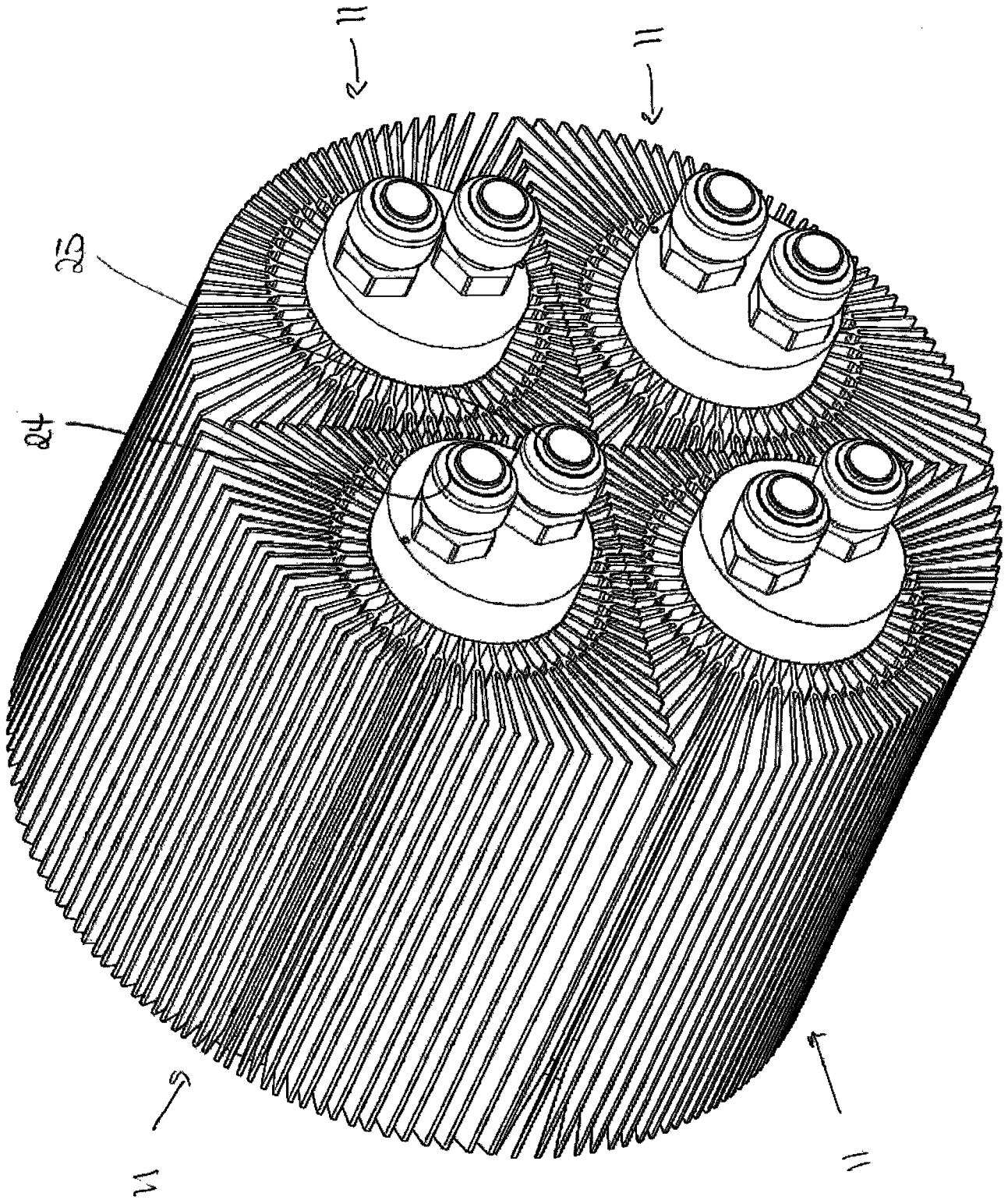


Fig 25

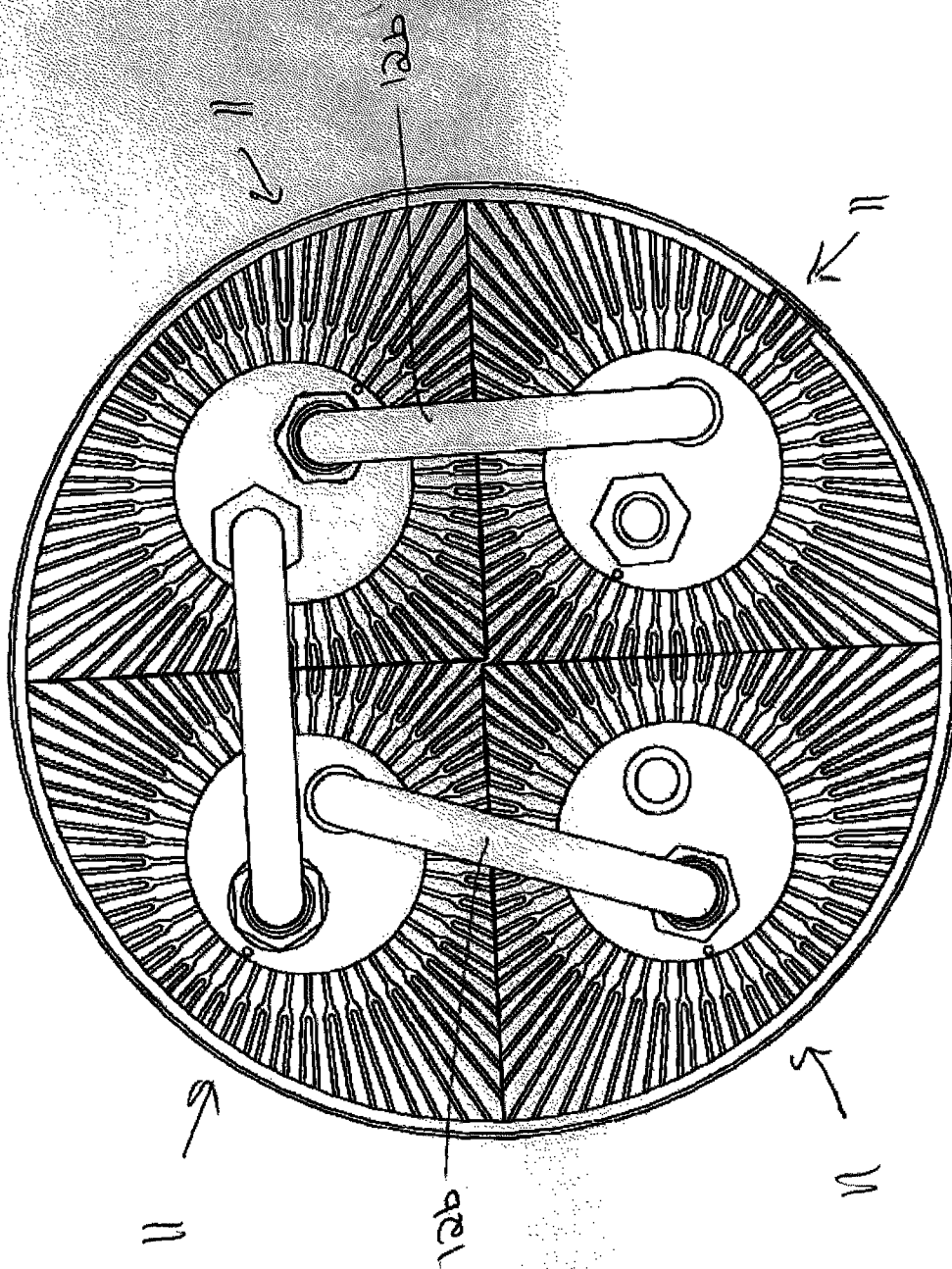


Fig 26

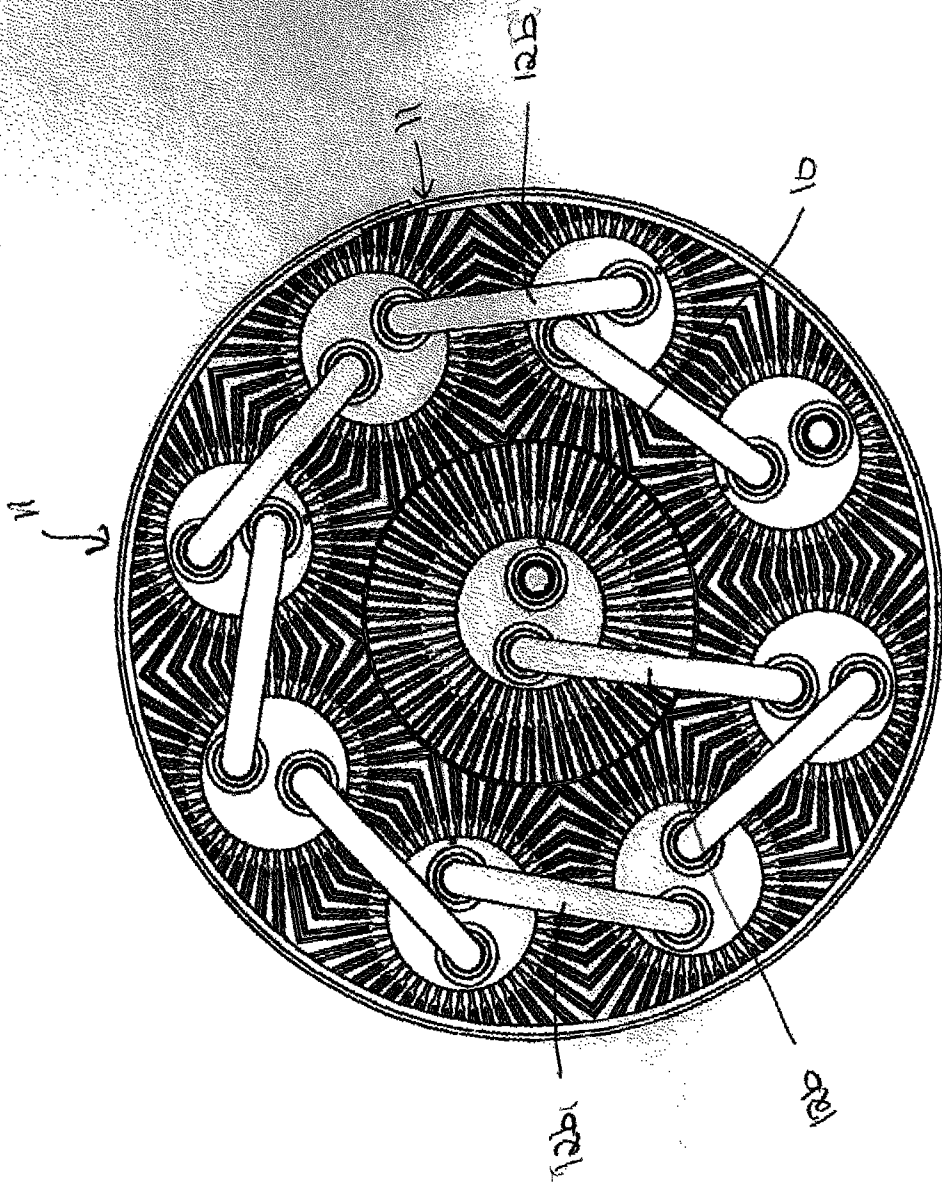
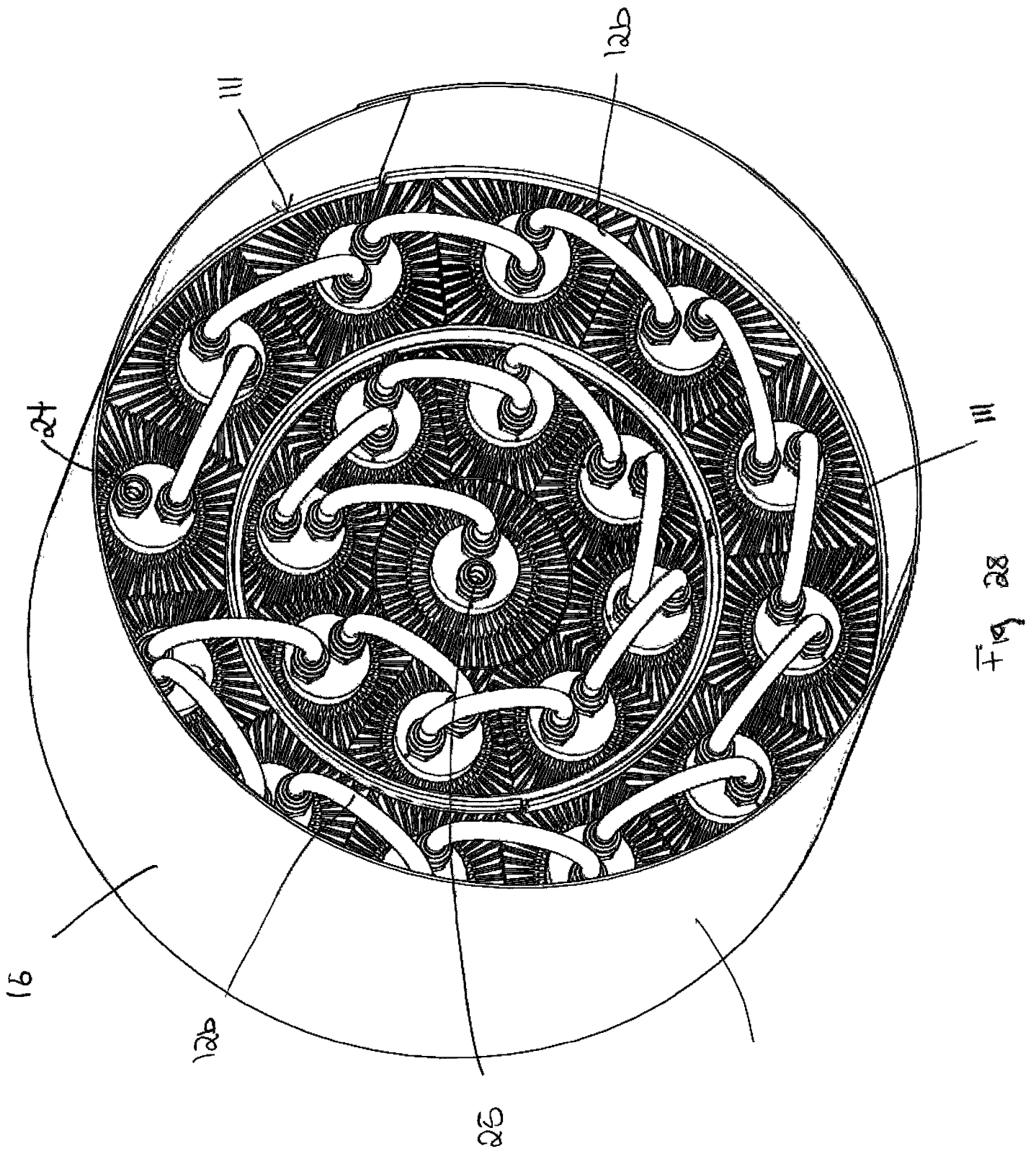


Fig 27



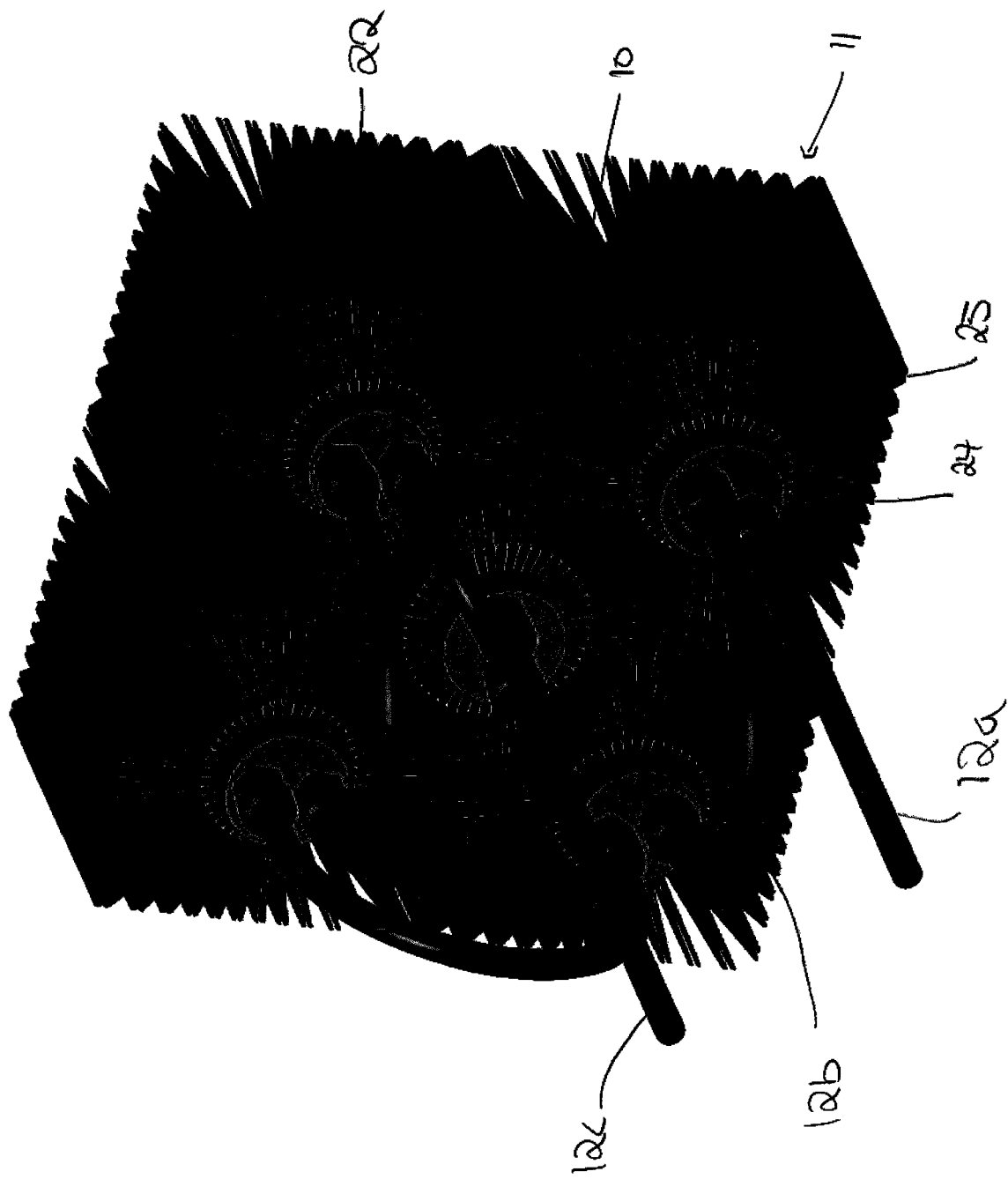


Fig 30



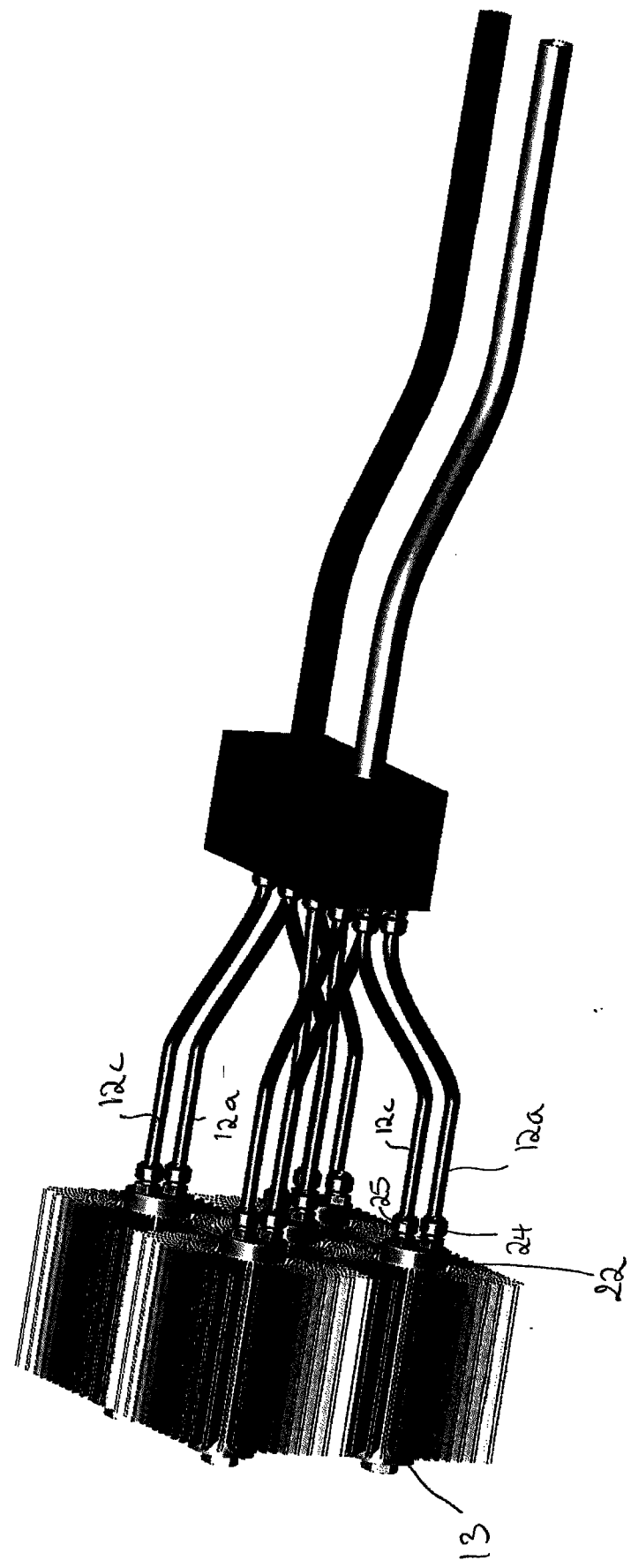


Fig 31



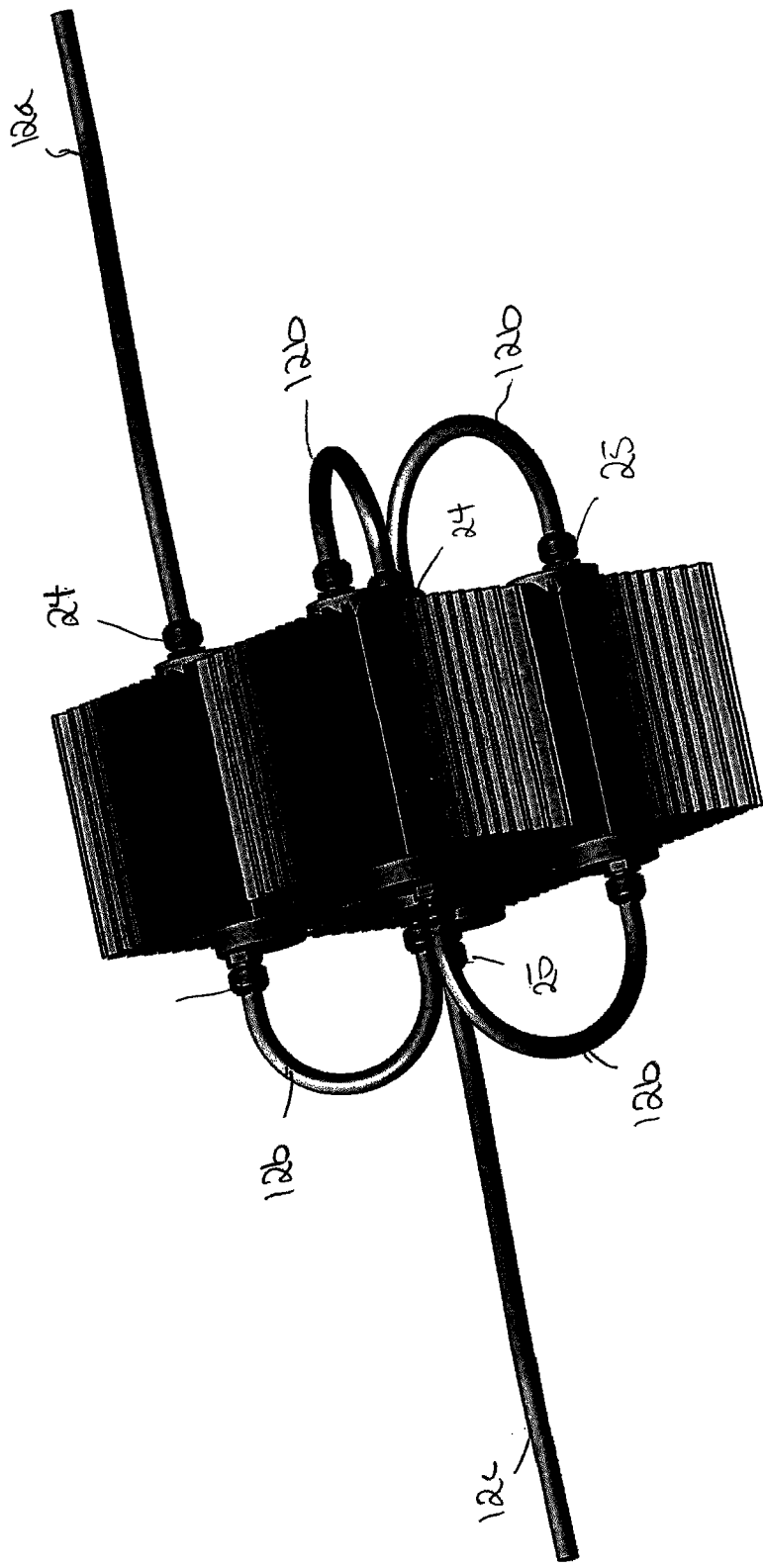


Fig 32



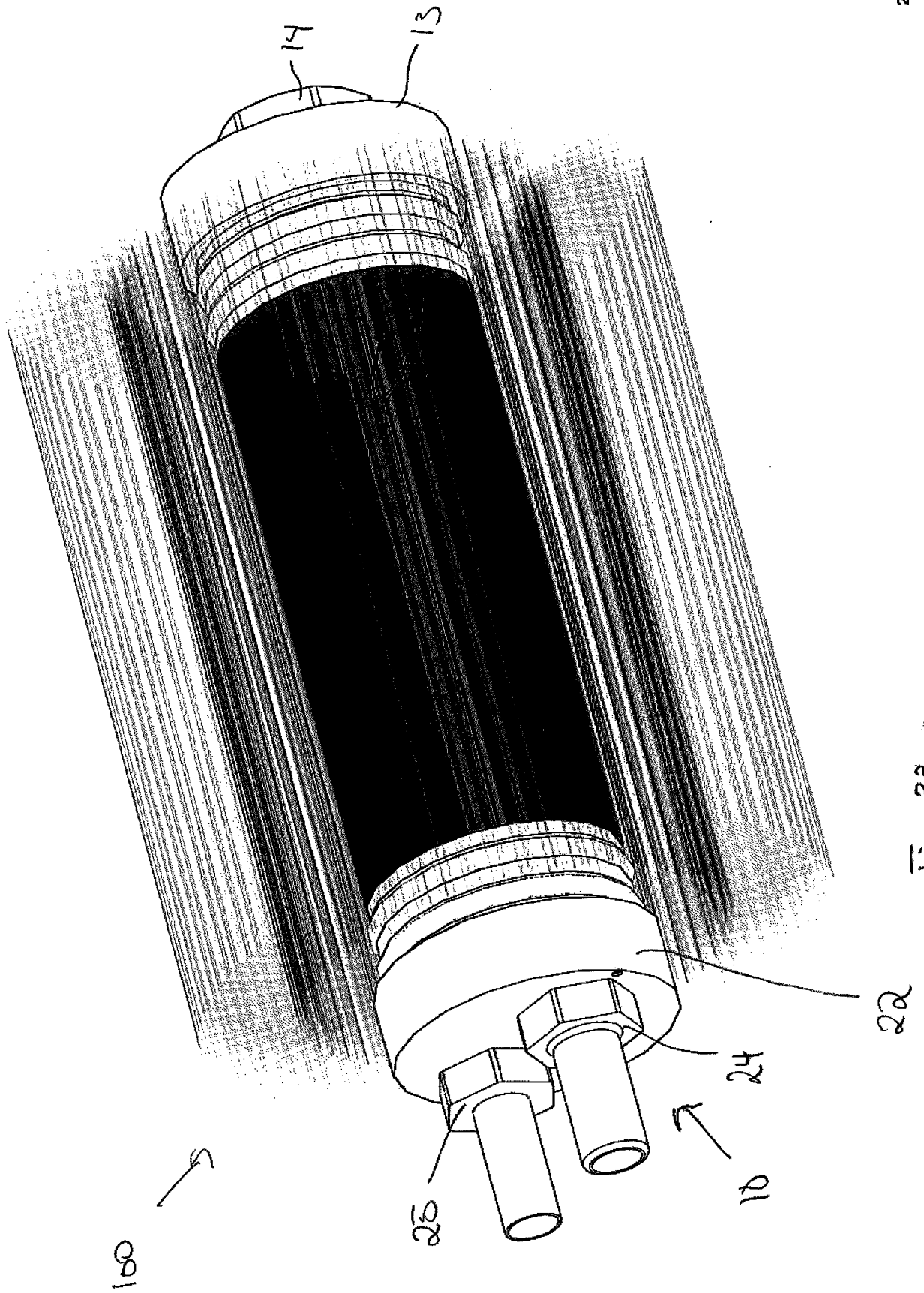


Fig 33

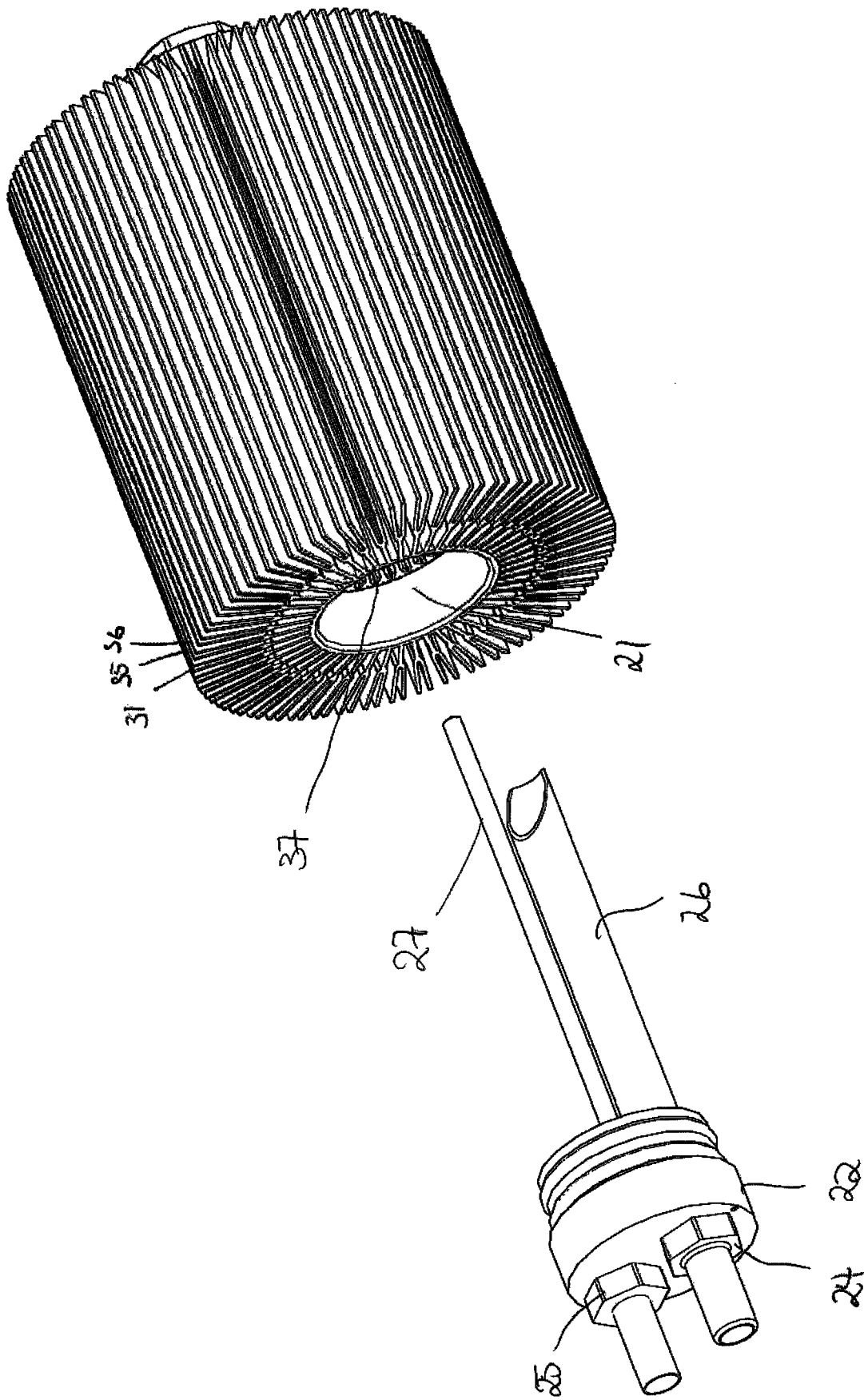


Fig 24

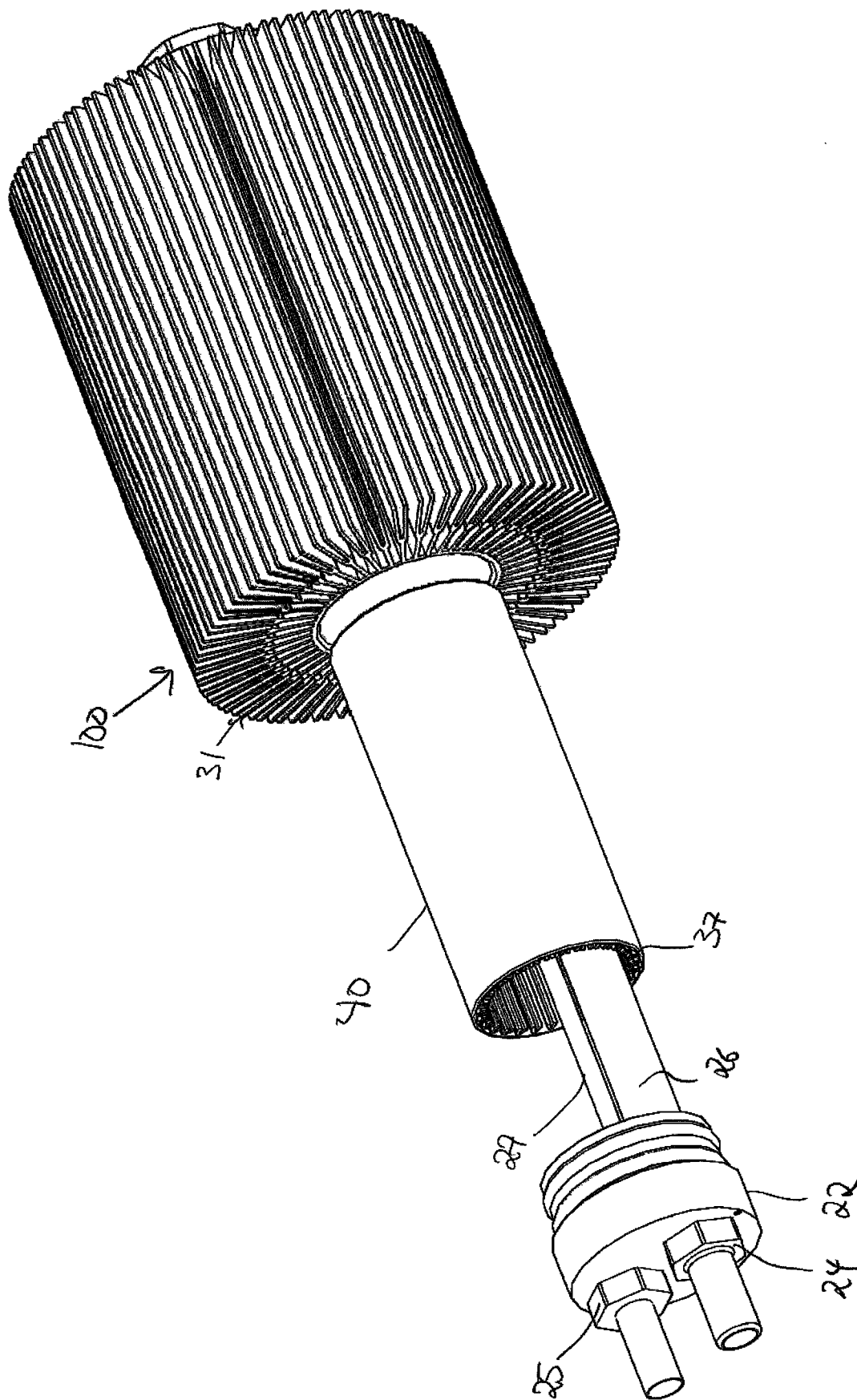


Fig 35

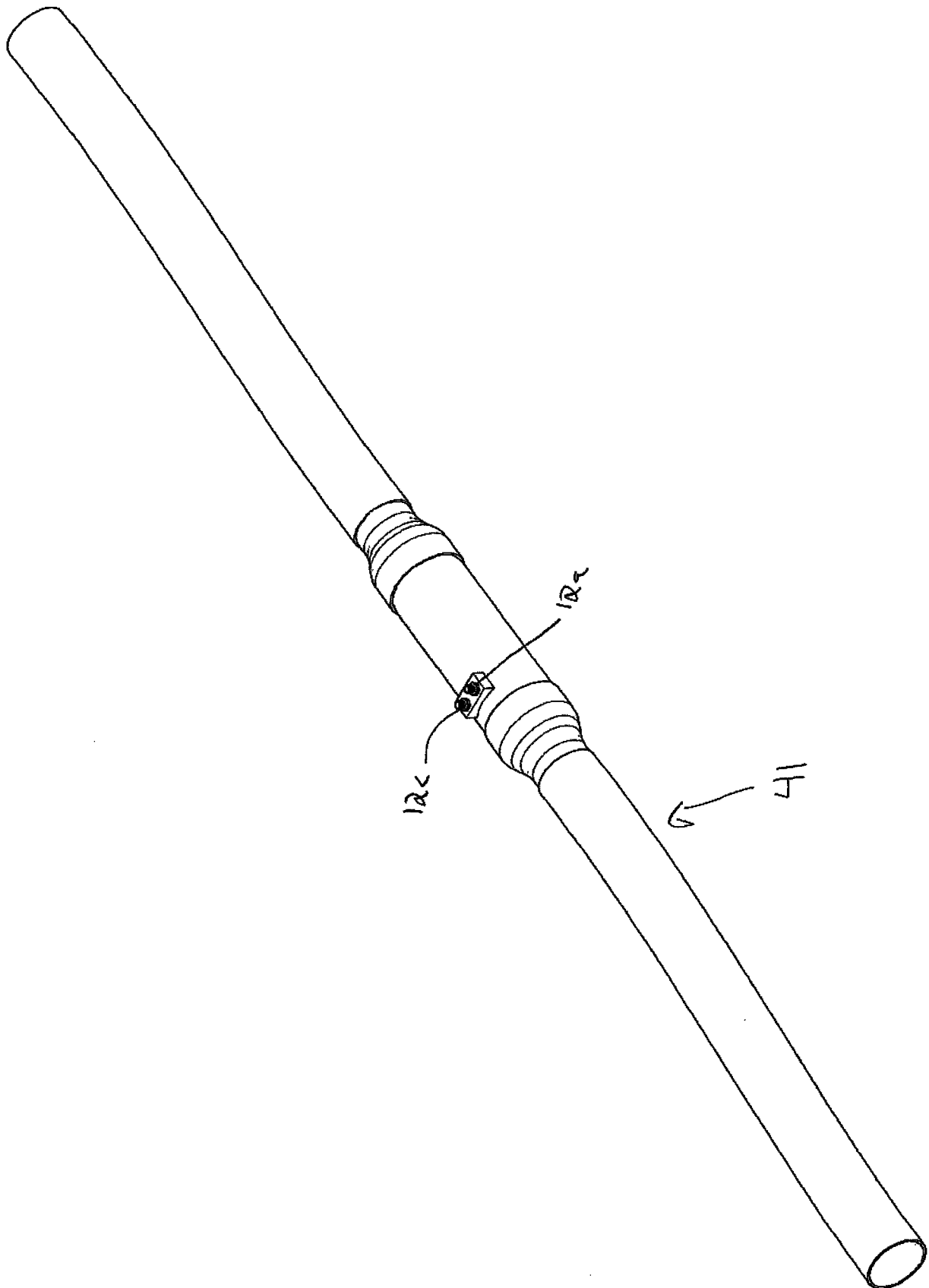


Fig 36

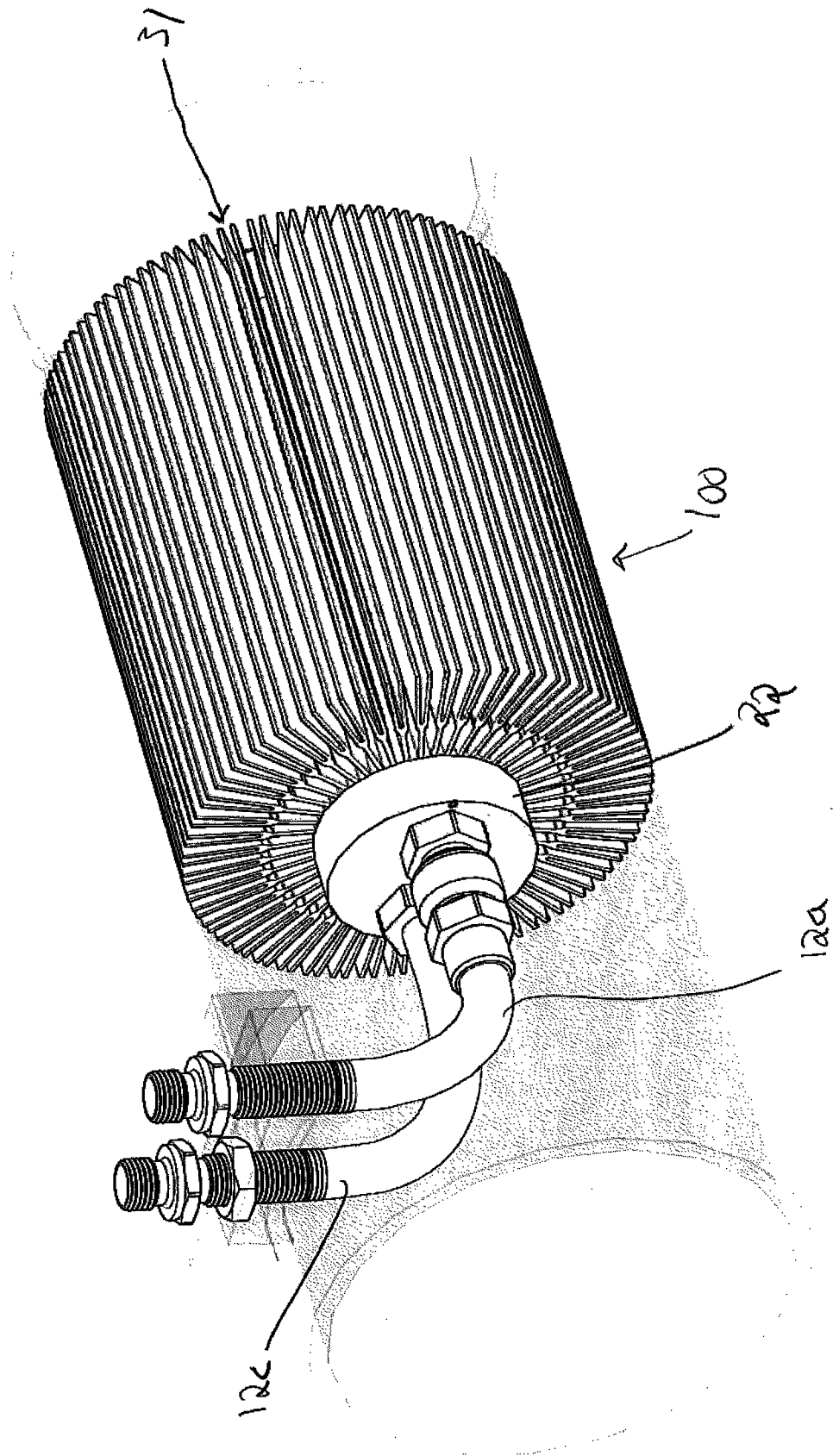
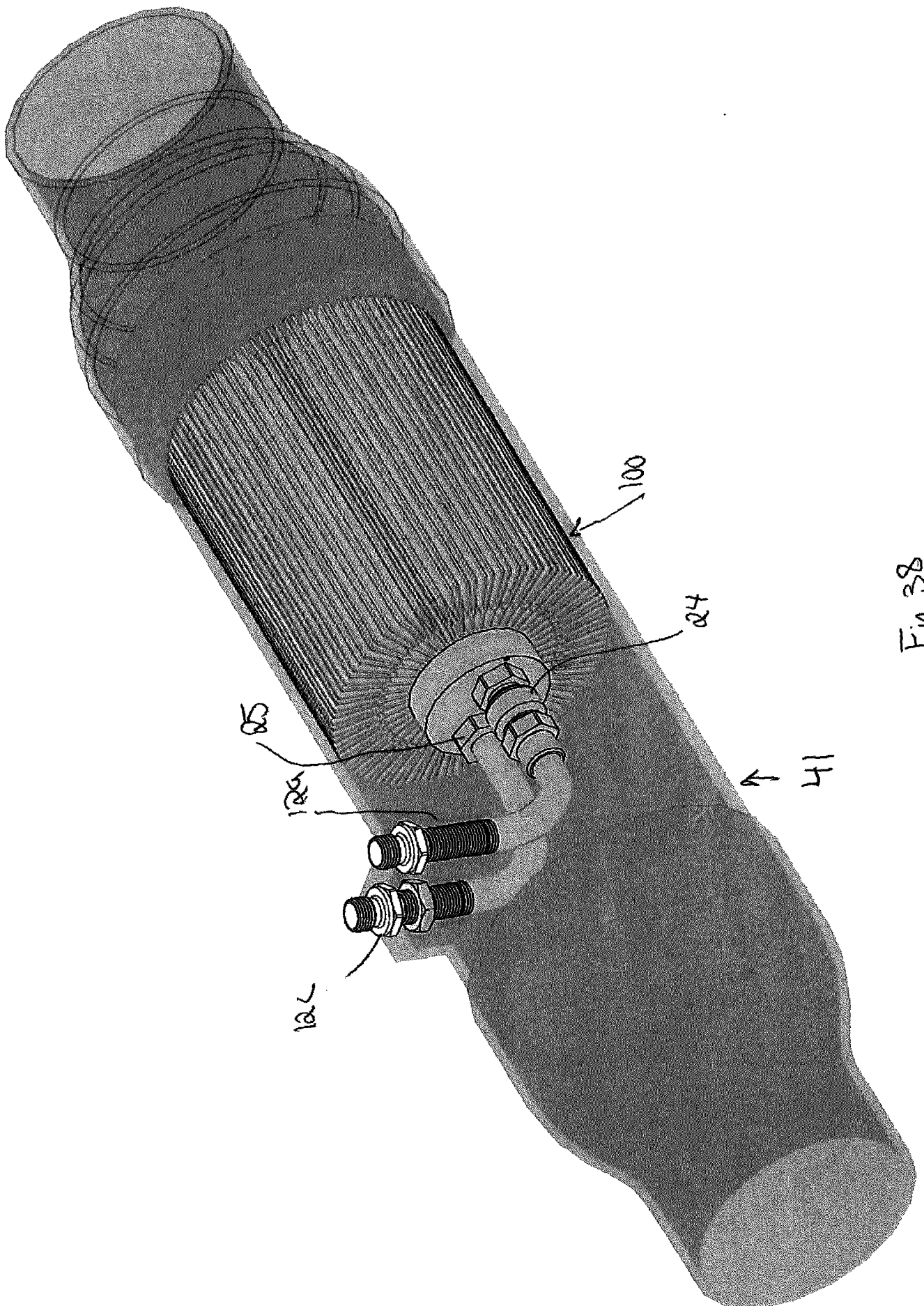
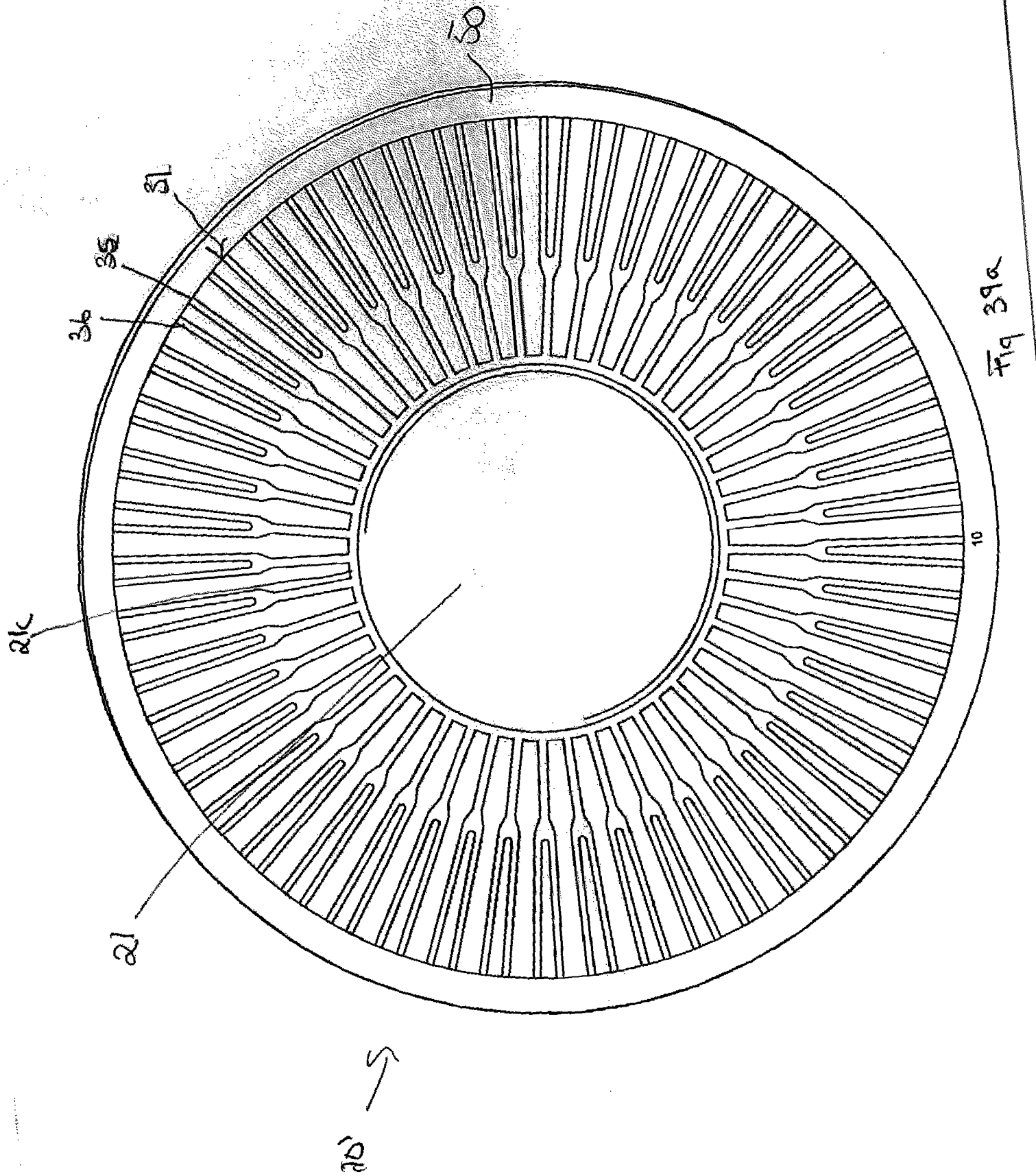
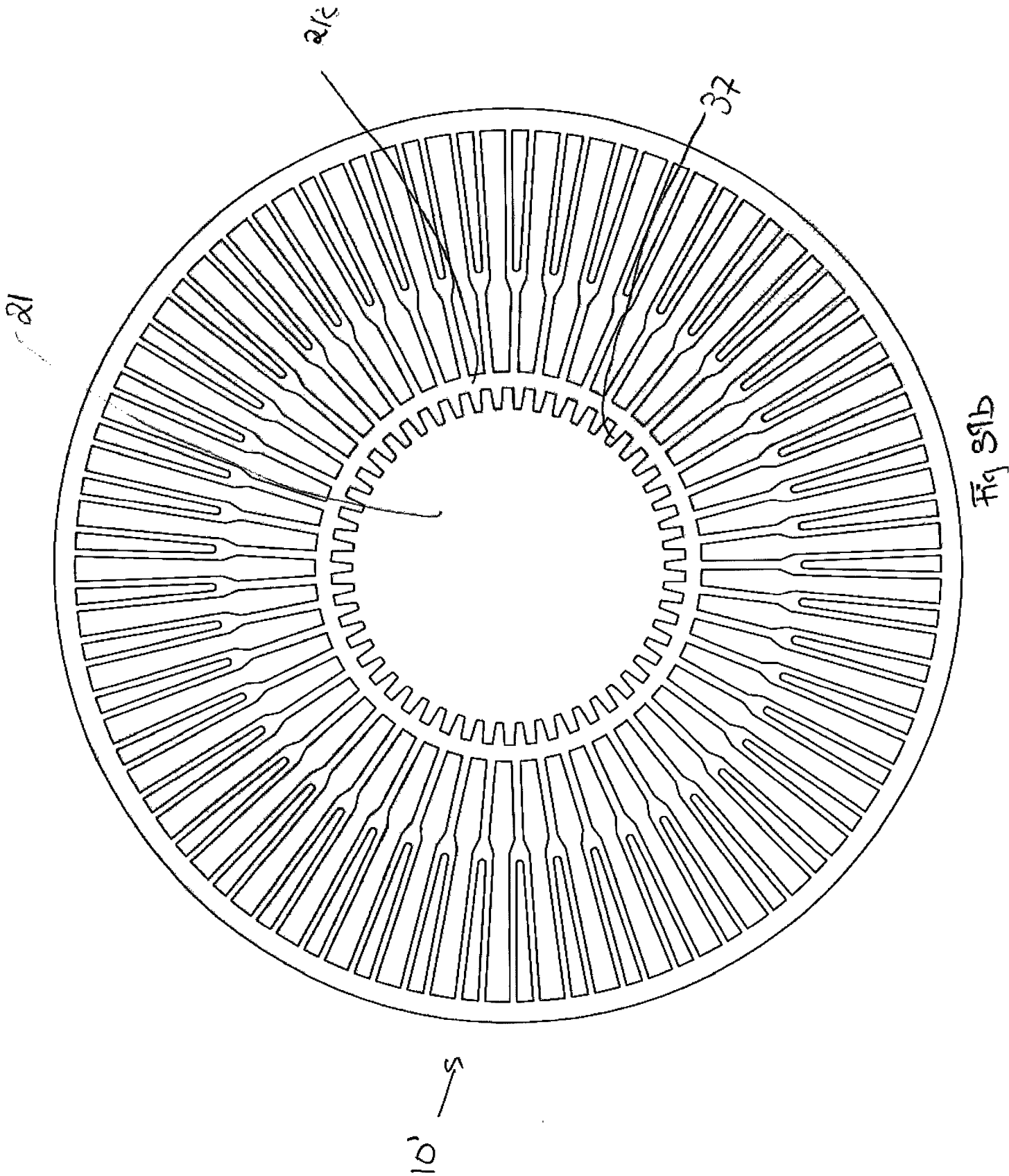


Fig 37







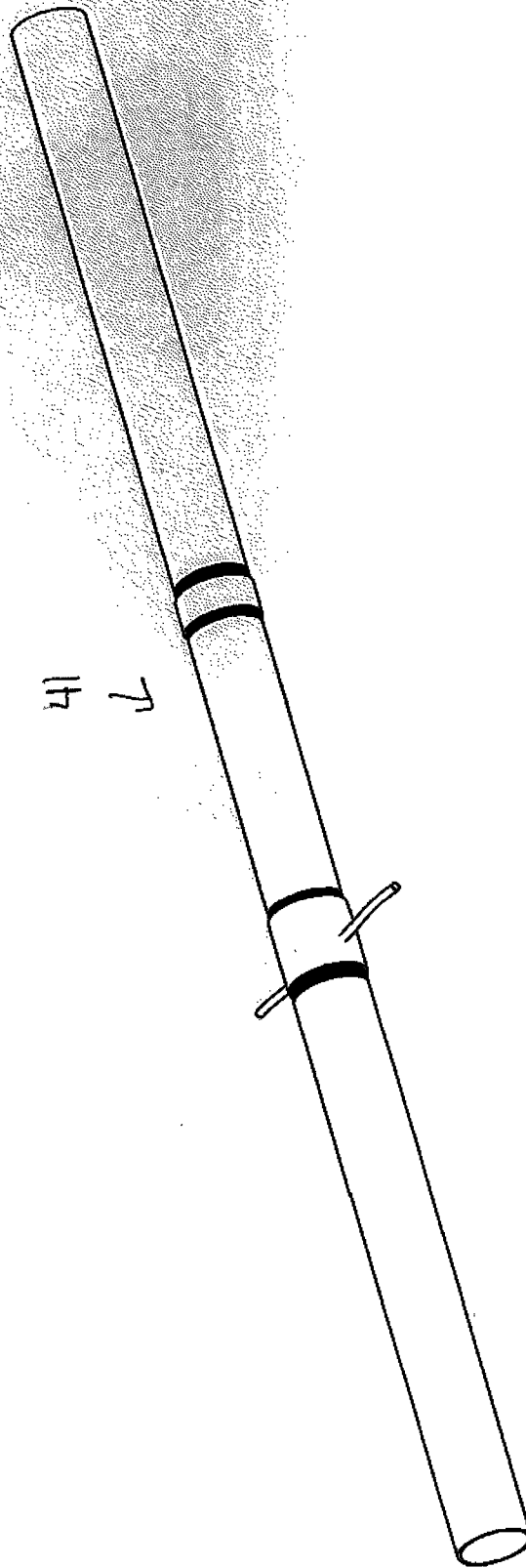
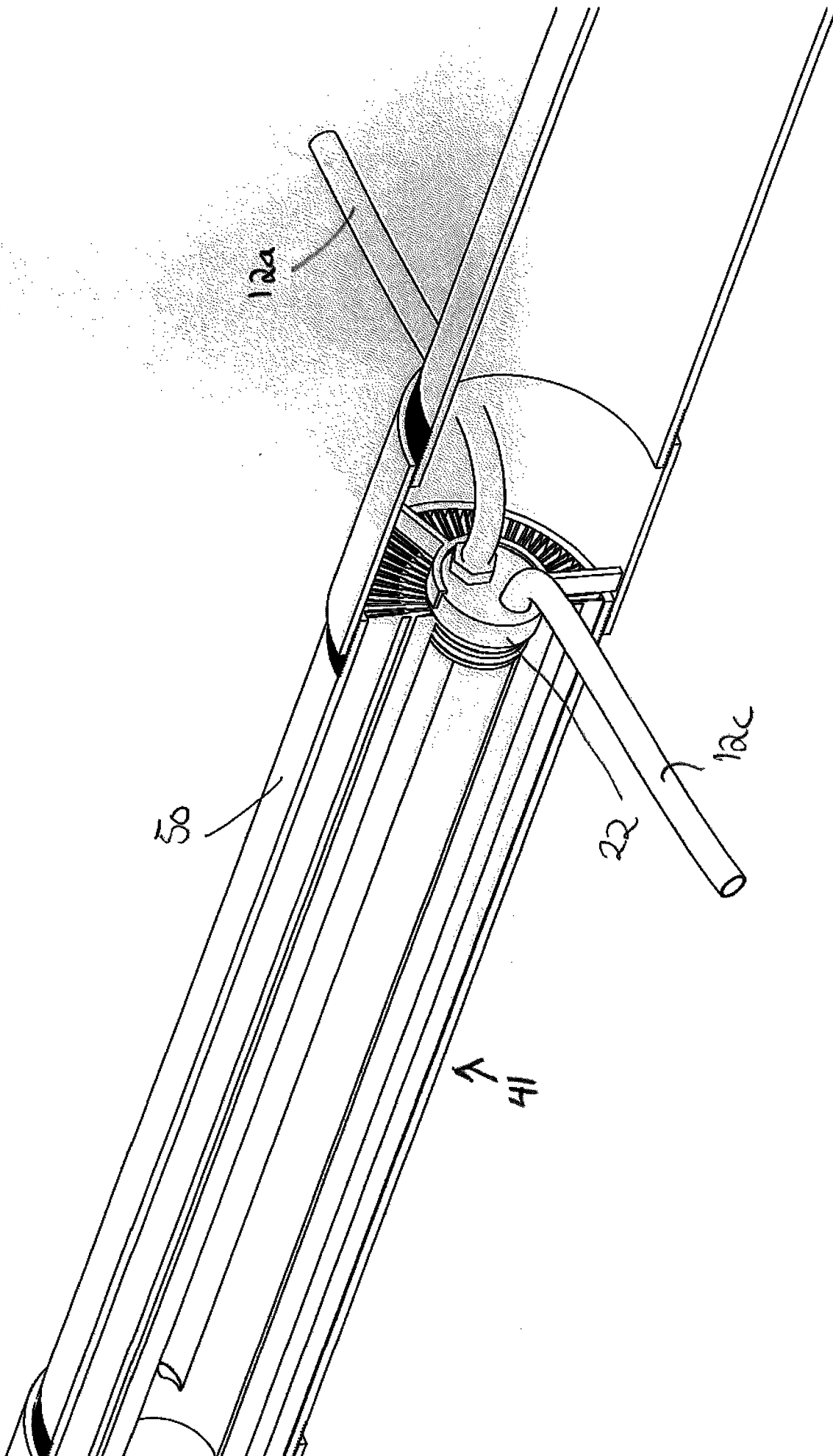
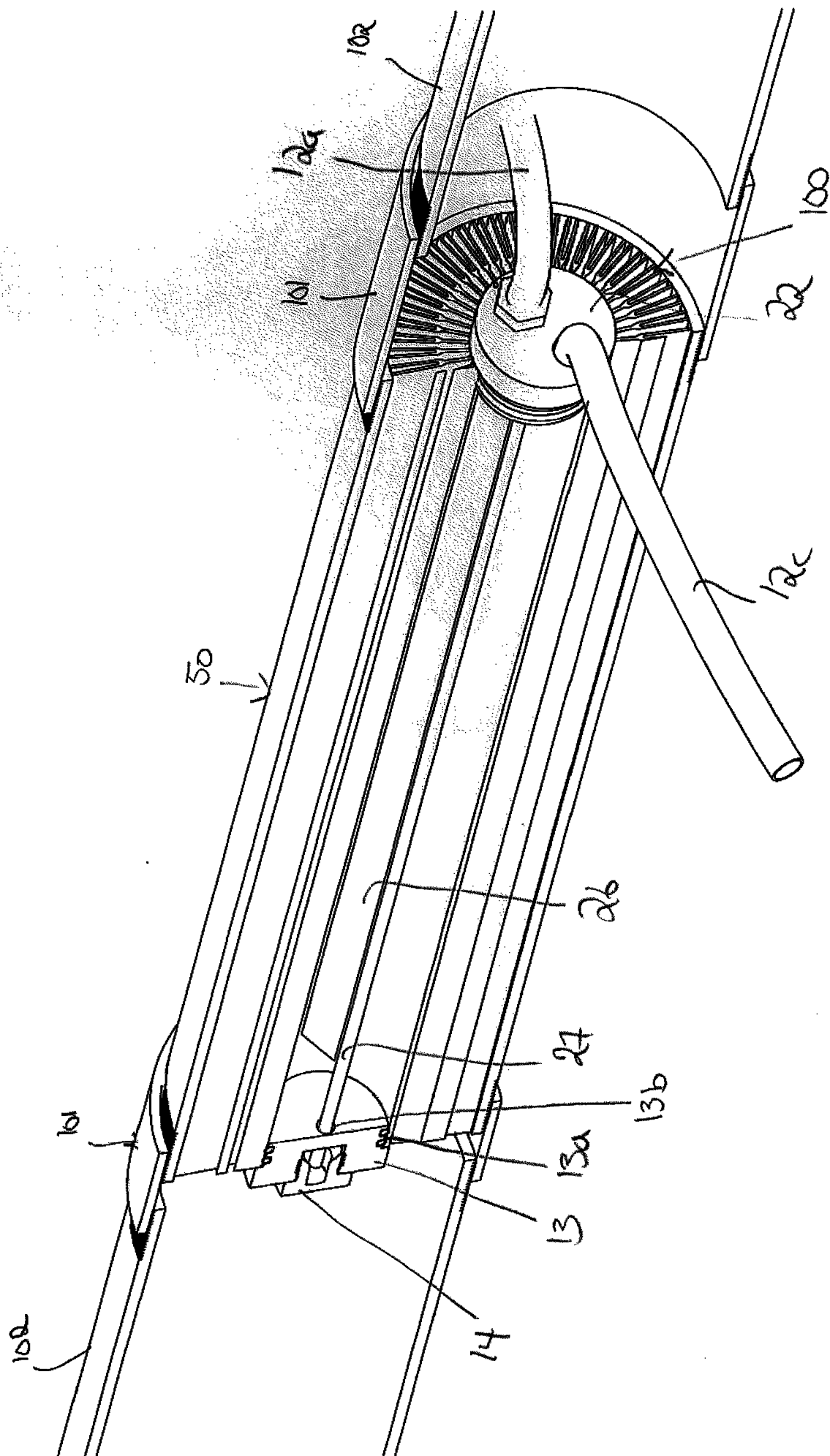
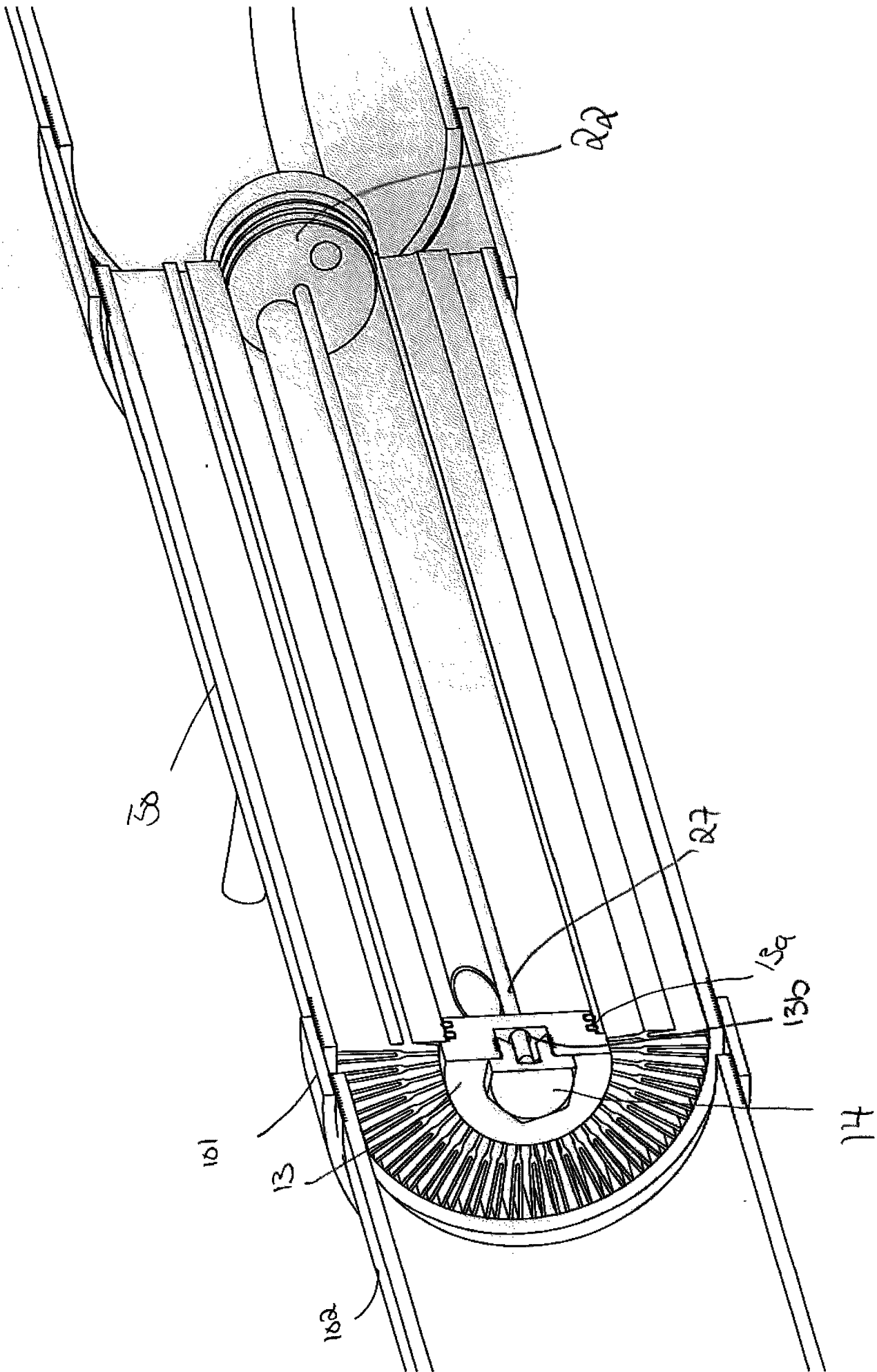


Fig 40

5







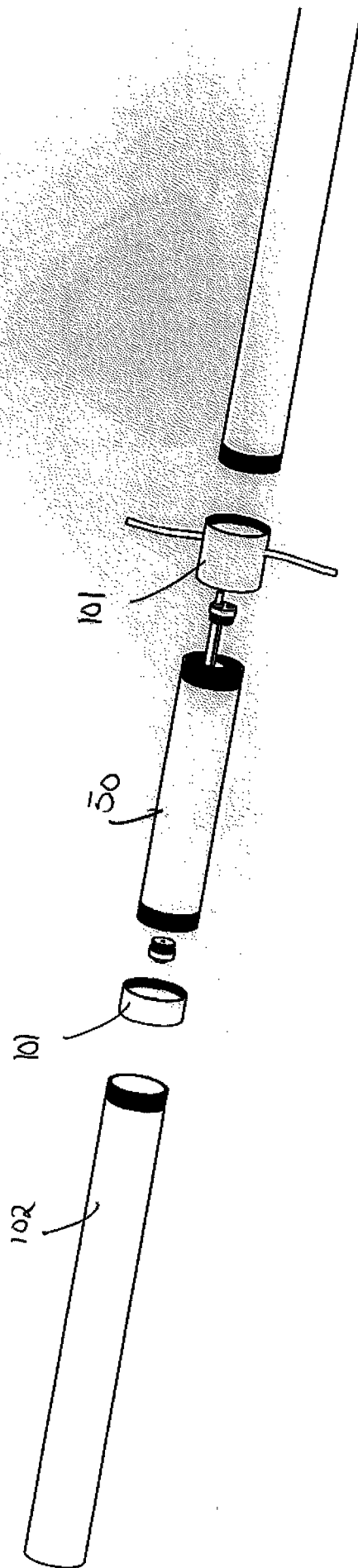
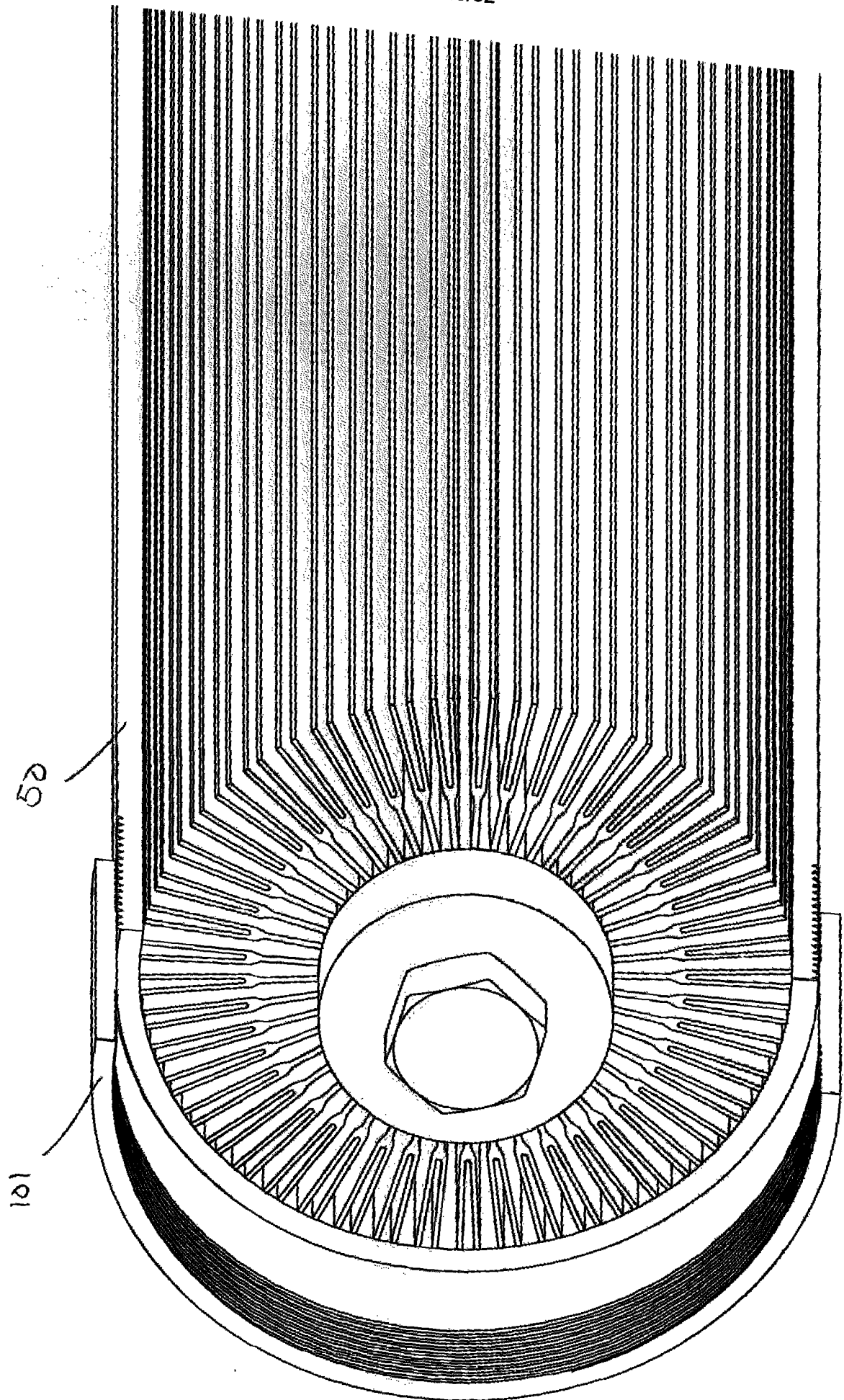


Fig. 4



12

Fig 45

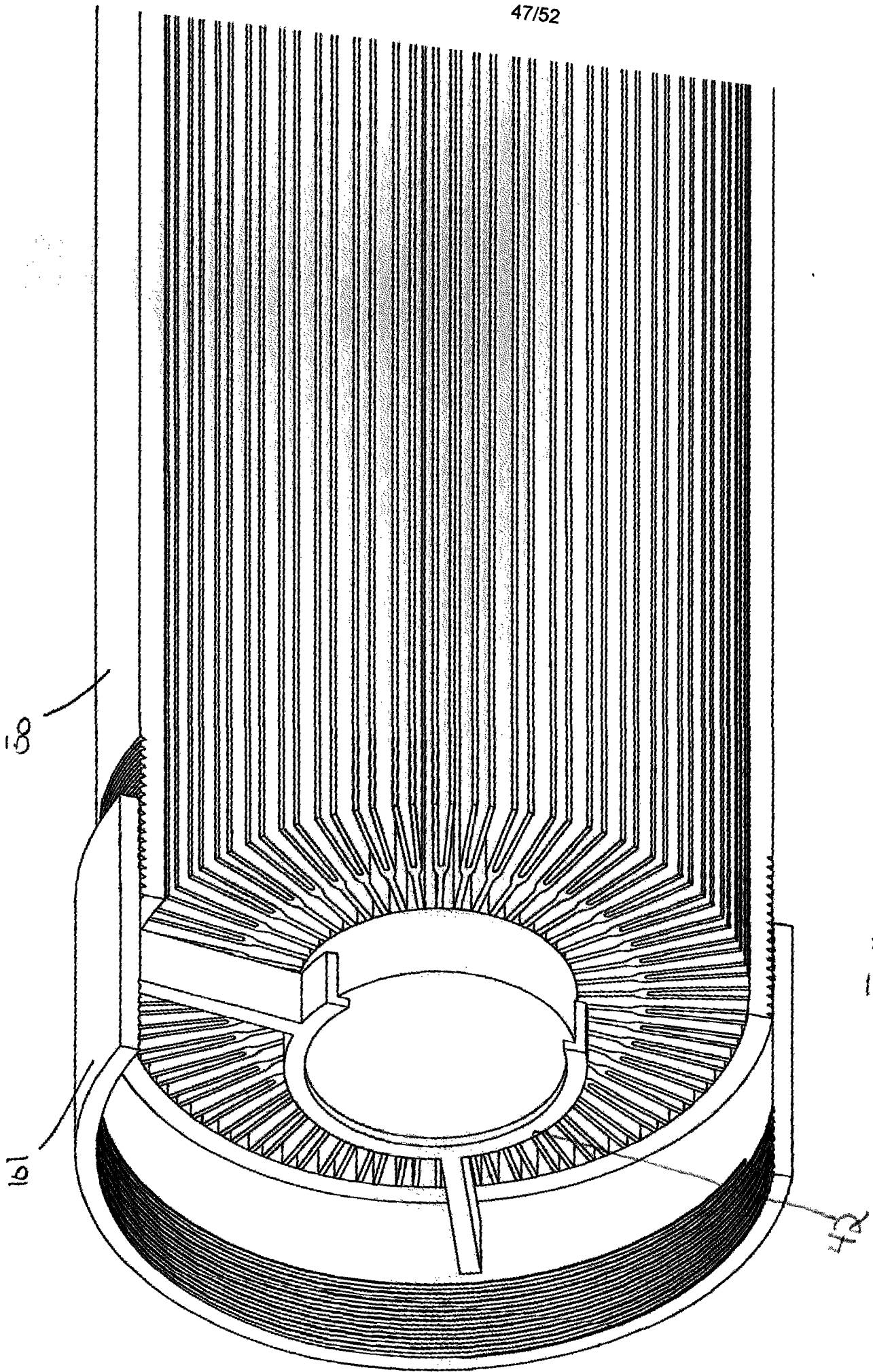


Fig 46

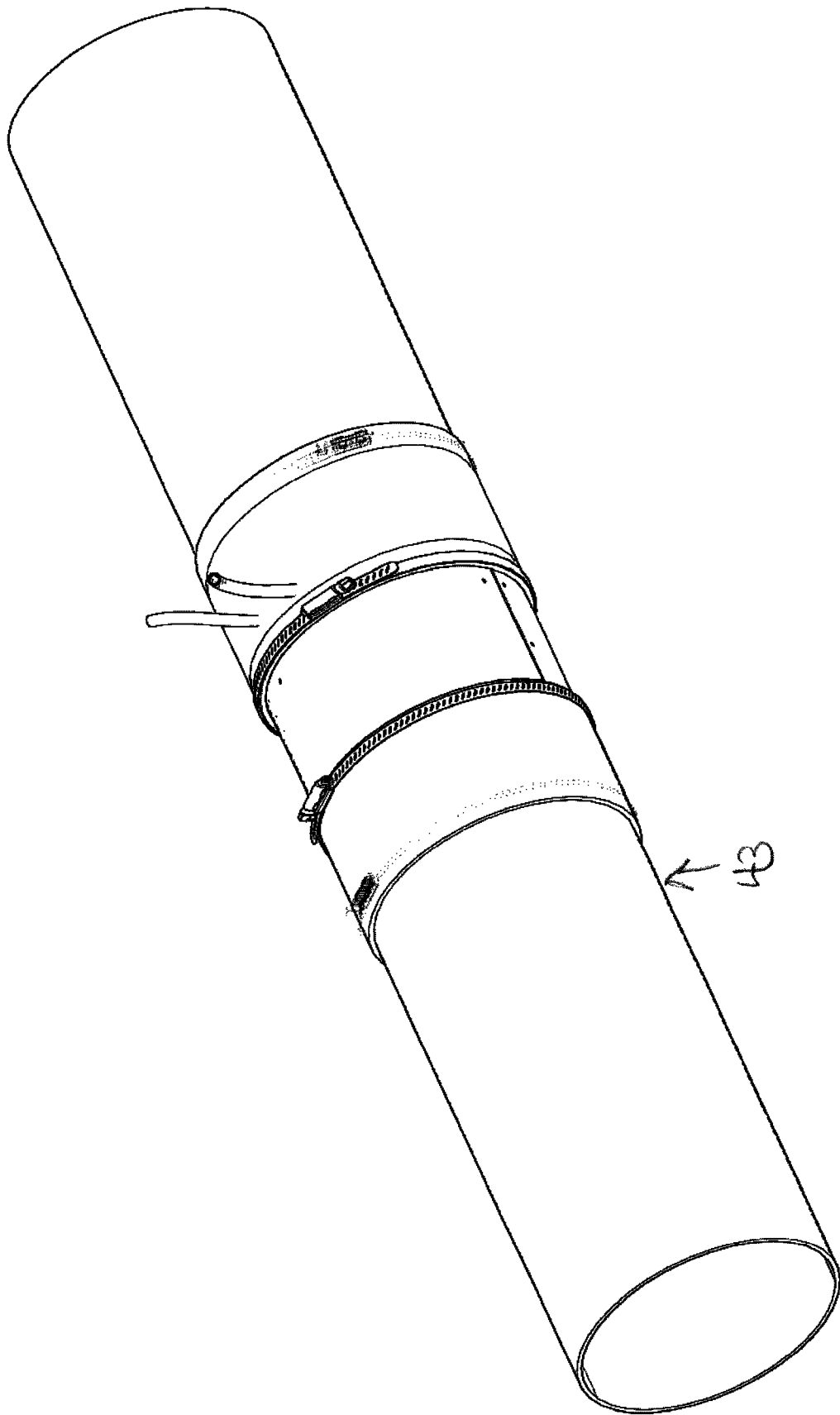


Fig 47

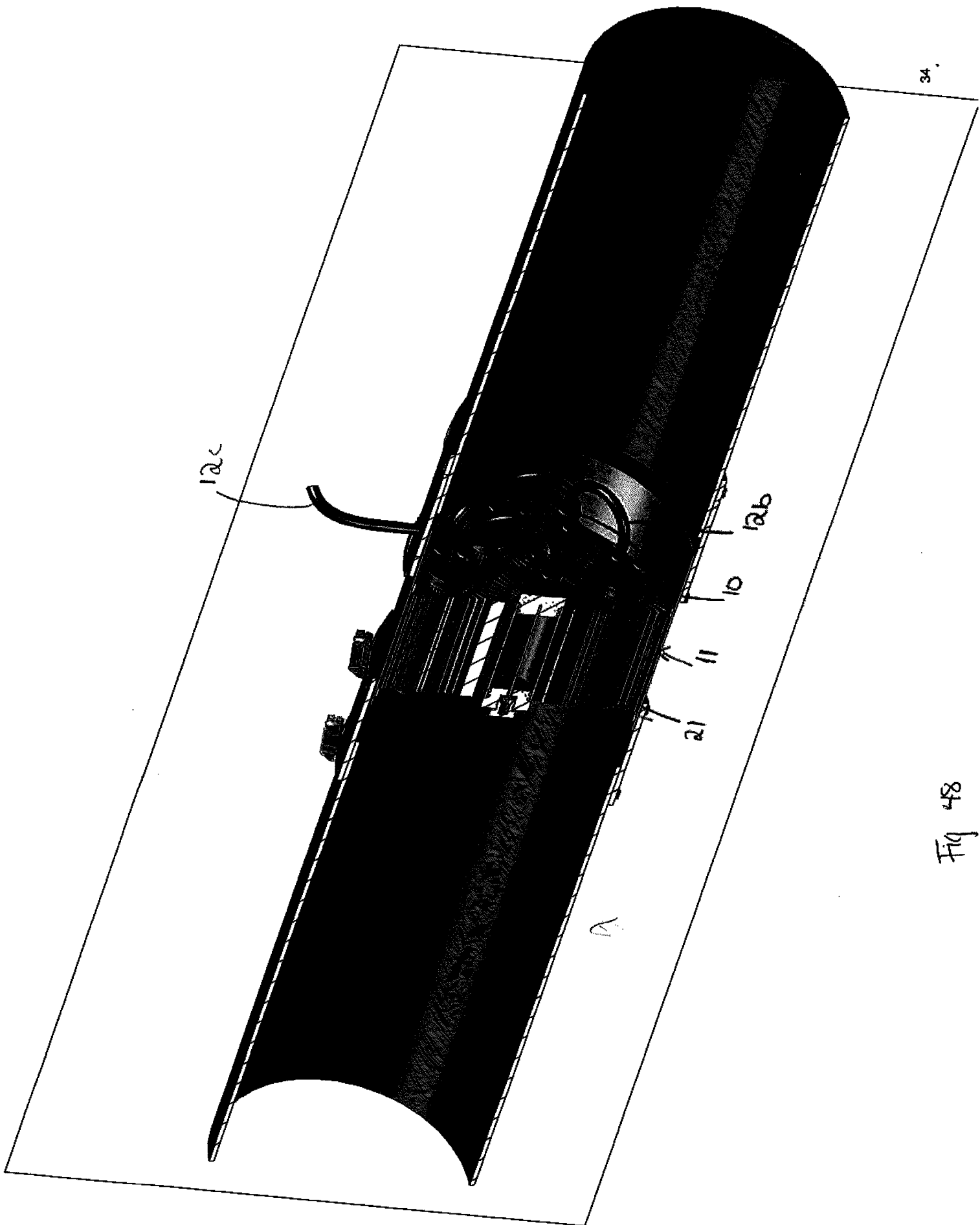


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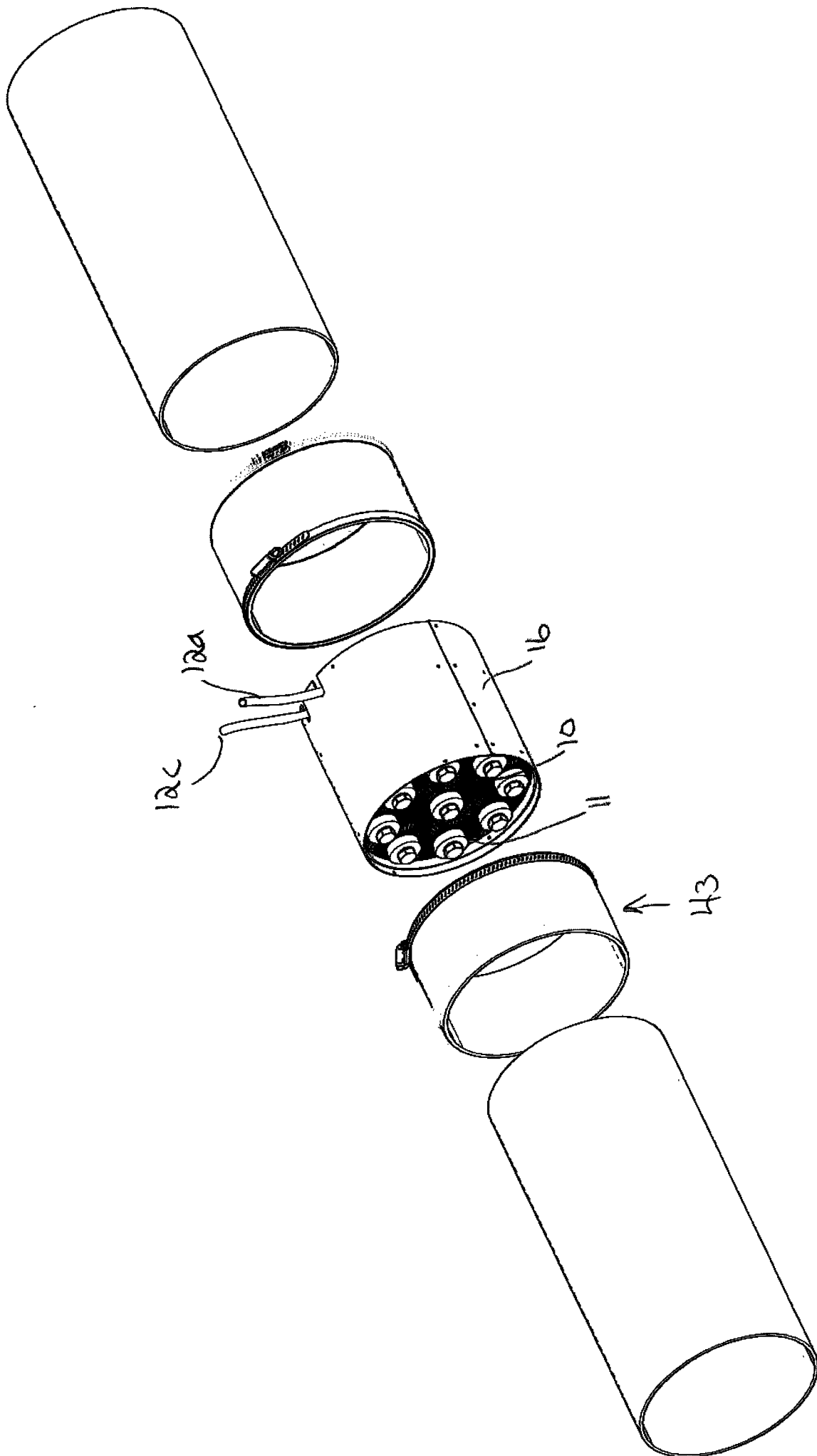


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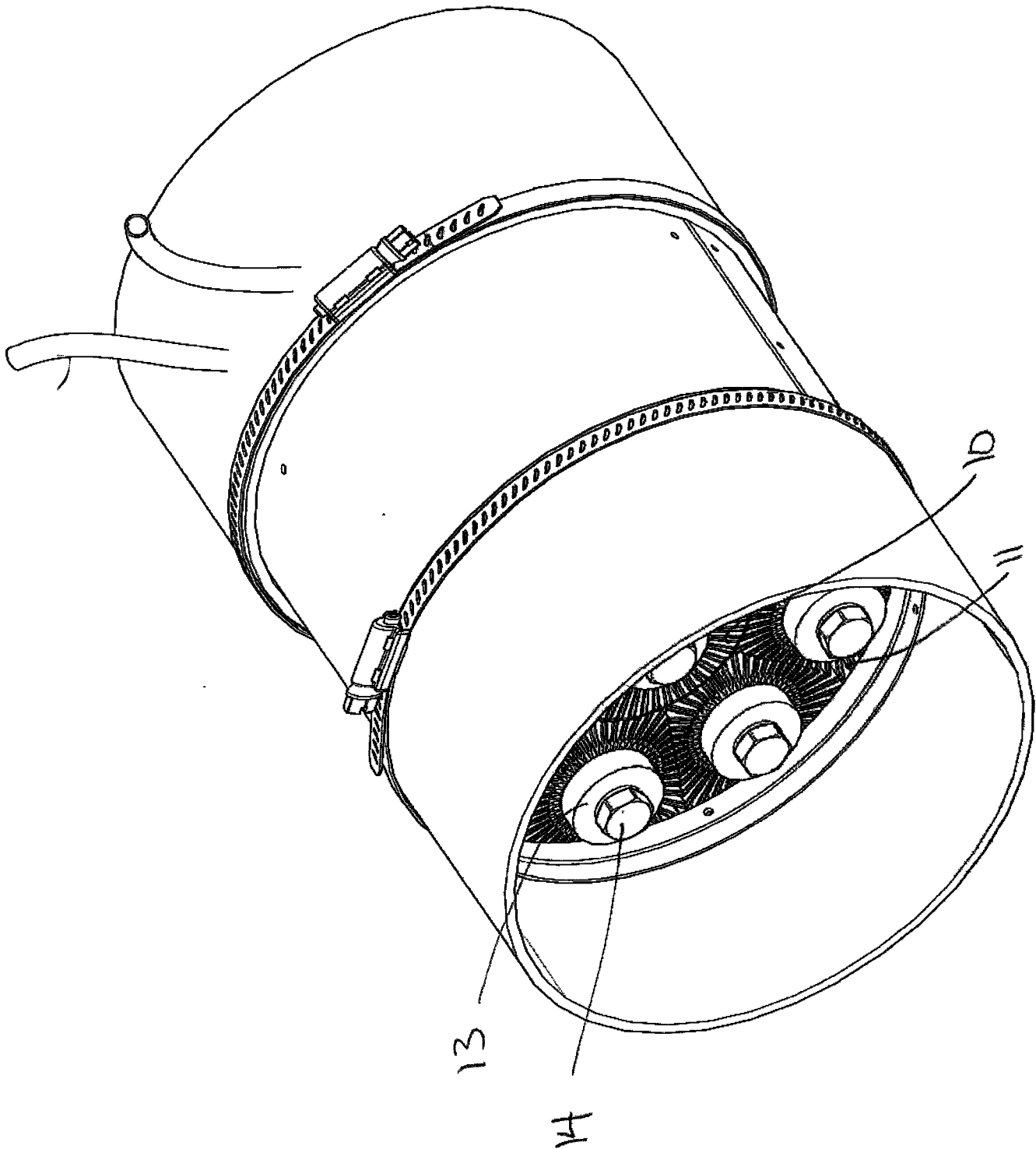


Fig 50

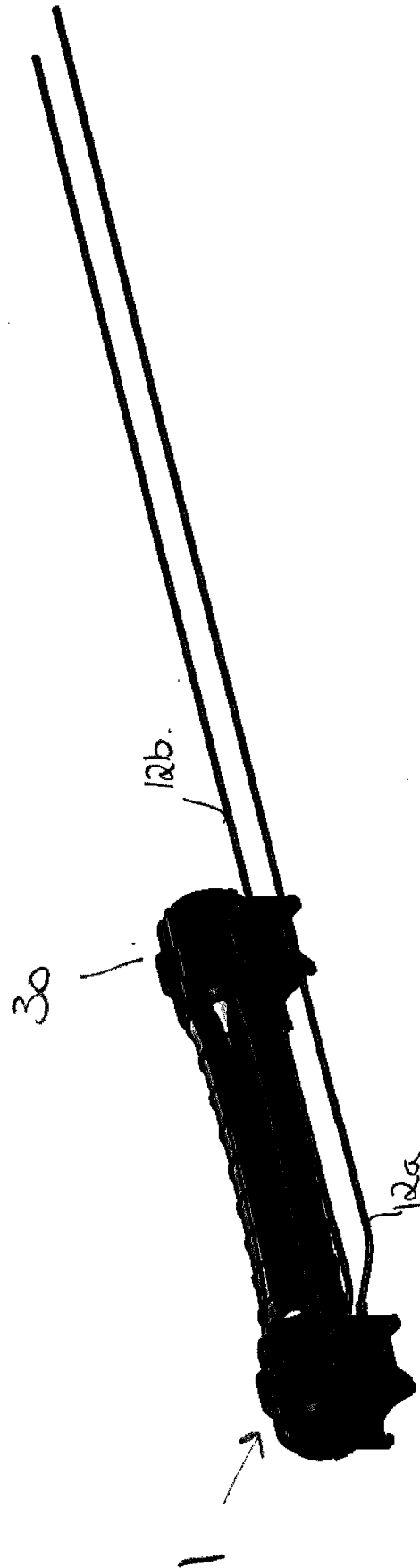


Fig 51