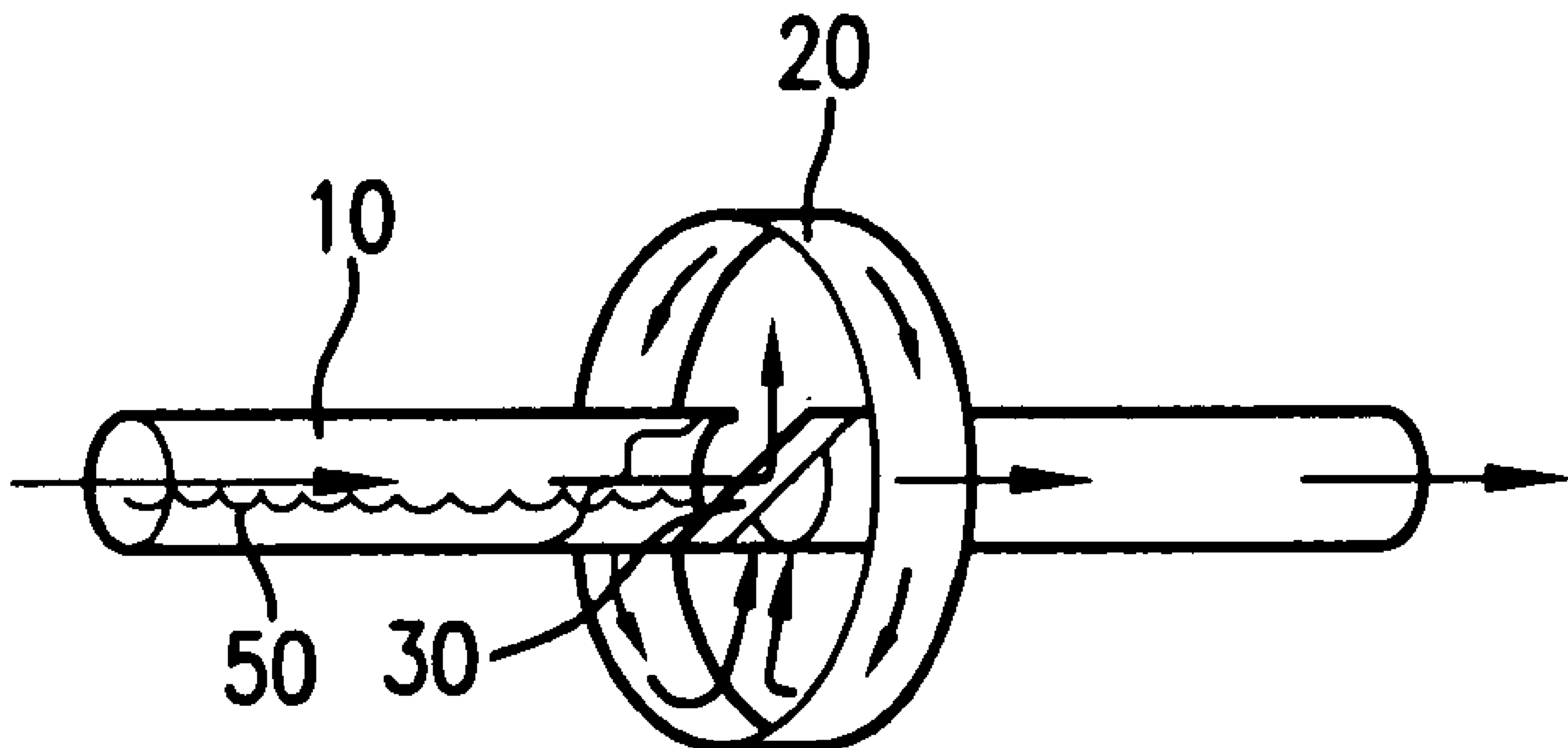




(86) Date de dépôt PCT/PCT Filing Date: 2009/04/20
(87) Date publication PCT/PCT Publication Date: 2009/10/29
(45) Date de délivrance/Issue Date: 2012/07/10
(85) Entrée phase nationale/National Entry: 2010/10/19
(86) N° demande PCT/PCT Application No.: US 2009/002432
(87) N° publication PCT/PCT Publication No.: 2009/131646
(30) Priorité/Priority: 2008/04/21 (US12/148,655)

(51) Cl.Int./Int.Cl. *F28F 13/08* (2006.01)
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(54) Titre : TUBE POUR ECHANGEUR DE CHALEUR
(54) Title: TUBE FOR A HEAT EXCHANGER



(57) Abrégé/Abstract:

A tube for a heat exchanger includes a first segment that couples to a chamber for transportation of heat exchange media. The chamber receives the heat exchange media that disperses throughout the chamber and mixes within the chamber. The heat exchange media is then transported from the chamber. The chamber may include redirection members for controlling the direction in which the heat exchange media travels throughout the chamber. The tube may be connected to a header or manifold. The tube and chamber combination alone may be used as a heat exchanger.

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
29 October 2009 (29.10.2009)



(10) International Publication Number
WO 2009/131646 A1

(51) International Patent Classification:
F28F 13/08 (2006.01)

(21) International Application Number:
PCT/US2009/002432

(22) International Filing Date:
20 April 2009 (20.04.2009)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
12/148,655 21 April 2008 (21.04.2008) US

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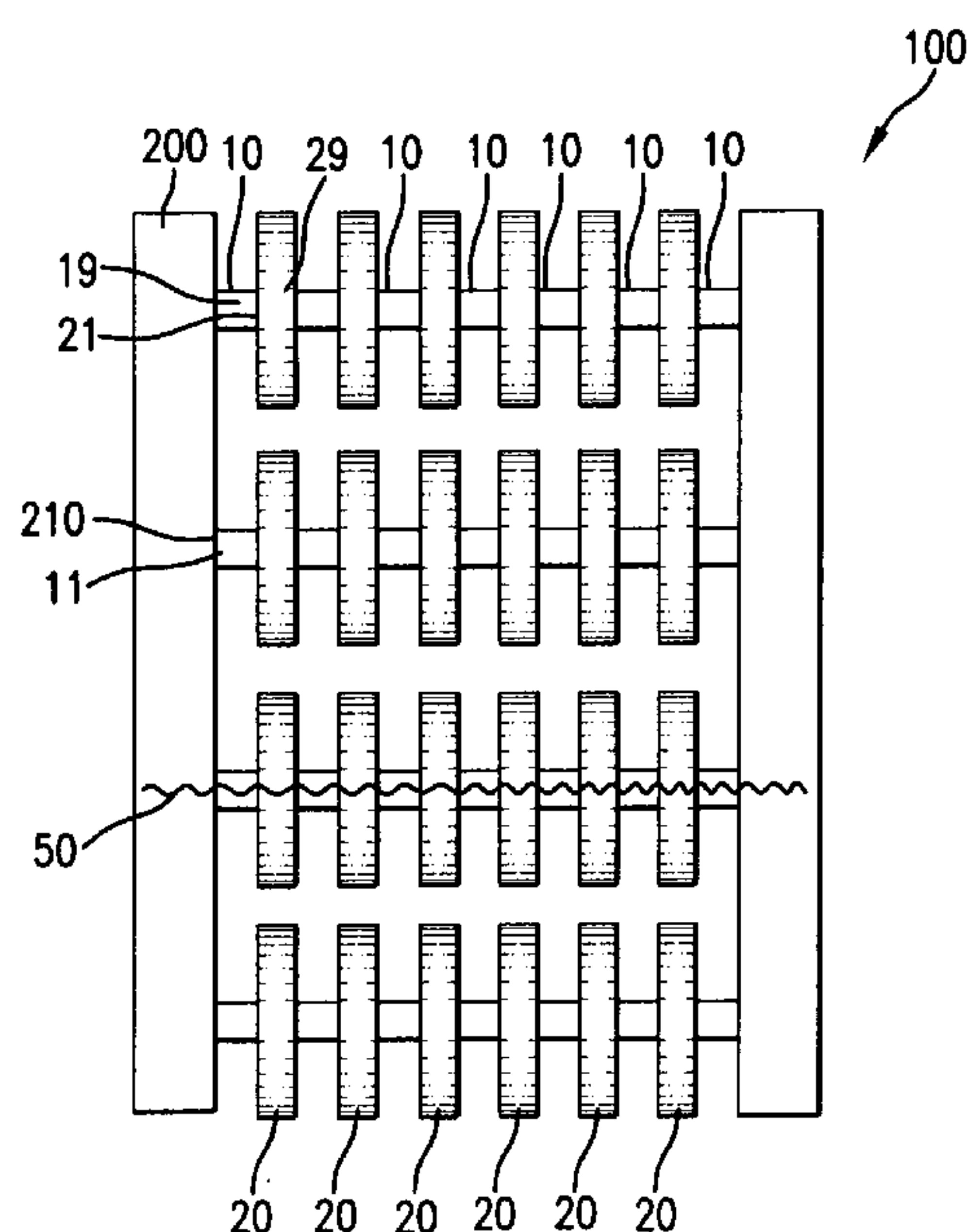
(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:

— with international search report (Art. 21(3))

(54) Title: TUBE FOR A HEAT EXCHANGER



(57) Abstract: A tube for a heat exchanger includes a first segment that couples to a chamber for transportation of heat exchange media. The chamber receives the heat exchange media that disperses throughout the chamber and mixes within the chamber. The heat exchange media is then transported from the chamber. The chamber may include redirection members for controlling the direction in which the heat exchange media travels throughout the chamber. The tube may be connected to a header or manifold. The tube and chamber combination alone may be used as a heat exchanger.

FIG. 1

TUBE FOR A HEAT EXCHANGER**BACKGROUND OF THE INVENTION****[0001] Field of the Invention**

[0002] The present invention relates generally to heat exchangers and, more specifically, to a tube and chamber apparatus for transporting heat exchange media.

[0003] Discussion of the Related Art

[0004] Heat exchangers are commonly utilized in systems where it is desired for heat to be removed. Typical basic heat exchangers are made of pipes, which channel heat exchanging media. Headers or manifolds are attached to each end of the pipes. These headers and manifolds act as receptacles for the heat exchanging media. The efficiency of the pipe heat exchangers is limited by the amount of surface area available for the transfer of heat.

[0005] To add more surface area, some heat exchangers, such as condensers, incorporate a “tube-and-fin” design. This type of heat exchanger typically includes flattened tubes having a fluid passing therethrough and a plurality of fins extending between the tubes. The fins are attached to the tubes to effectively increase the surface area of the tubes, thereby enhancing heat transfer capability of the tubes. A number of tubes and fins may be stacked on top of each other, which leaves a small opening to allow passage of air in between them. In another tube-and-fin design, the tube can be of a serpentine design, therefore eliminating the need for headers or manifolds, as the tube is bent back and forth in an “S” shape to create a similar effect. Typical applications of this type of heat exchanger, besides condensers, are evaporators, oil coolers, and heater cores. This tube-and-fin design is also utilized in radiators for automobiles. Outside of the automotive field, the tube and fin design is implemented by industrial oil coolers, compressor oil coolers, and in other similar applications requiring a higher efficiency heat exchanger.

[0006] In another effort to create a greater exchange of heat by increasing surface area, very thin flat tubes with intricate inner rib structures are utilized. This type of heat exchanger is similar to the tube-and-fin design, in that fins are combined with the flat tubes, but in this particular type of heat exchanger, the flat tubes contain intricate internal chambers formed by the inner rib structures. These inner rib structures help to increase the heat exchanging performance of the heat exchanger. To further improve heat transfer efficiency, the tube thickness is made thinner. As a result, the parts are lighter in weight, which in turn makes the overall heat exchanger lighter in weight. However, the pressure resistance is reduced, and the thinner tubes are more prone to damage. Also, the assembly process is complicated because of the fragile nature of the parts. In addition, the internal chambers are prone to plugging during the manufacturing process, particularly if a brazing process is utilized. The complexity of the extruding process potentially results in higher costs and higher defect rates. Also, by utilizing internal chambers within the flat tubes to help disperse heat, the overall cost for the heat exchanging system will be higher because a higher powered compressor may be necessary to move the heat exchanging medium through the smaller openings of the tubes. Conversely, if a higher powered compressor is not utilized, then additional tubes will be necessary to obtain the desired heat exchanging performance because the smaller tubes reduce the flow of the heat exchange media significantly. The additional tubes will increase the overall cost for the heat exchanging system. Currently, this type of heat exchanger is used in applications requiring high heat exchanging capabilities, such as automotive air conditioner condensers.

[0007] A variation on the tube-based heat exchanger involves stacking flat ribbed plates. When stacked upon each other, these ribbed plates create chambers for transferring heat exchanging media. In essence, this type of heat exchanger performs substantially the same function as tube-and-fin type heat exchangers, but is fabricated differently. This type of heat exchanger is commonly implemented by contemporary evaporators.

SUMMARY OF THE INVENTION

[0008] The present invention is an enhanced tube for heat exchanging applications including a flow tube and a chamber. The flow tube connects to the chamber. One end of the flow tube may connect to a header or a manifold. Heat exchange media flows from the header or the manifold into the flow tube. The heat exchange media then flows into the chamber. The heat exchange media then flows from the chamber into another flow tube, which is connected to another header or manifold.

[0009] In an embodiment of the present invention, the flow tube and the chamber for a heat exchanger are provided, for example, for a condenser, evaporator, radiator, etc. The heat exchanger may also be a heater core, intercooler, or an oil cooler for an automotive application (i.e., steering, transmission, engine, etc.) as well as for non-automotive applications. An advantage of the present invention is that the heat exchange media contact surface area for radiating heat is greater over a shorter distance than that of a conventional heat exchanger. Therefore, the efficiency of the heat exchanger is increased. Another advantage of the present invention is that the overall length and weight of the enhanced tube for heat exchanging applications may be less compared to a conventional heat exchanger, which in turn provides for a lower overall cost as less raw material and less packaging is necessary. Furthermore, the smaller footprint of the present invention lends itself to be used in applications where space is limited. Yet another advantage of the present invention over a conventional heat exchanger is that the manufacturing process may be simpler because the present invention requires less fragile components and less manufacturing steps. The entire unit may be brazed together, or any portion of the unit can be brazed first, and then additional components may be brazed or soldered together.

[0010] In another embodiment of the present invention, more than one chamber may be used, which will further increase the surface area of the enhanced tube for the heat exchanger. Also, a first chamber may be connected directly to another chamber.

[0011] In yet another embodiment of the present invention, the tube size may vary between the chambers, and if more than one chamber is used, the chamber size may vary from one chamber to the next.

[0012] In a further embodiment of the present invention, each chamber may disperse heat exchanging media throughout the chamber, which further enhances the heat exchanging capabilities of the present invention. Also, each chamber may also mix heat exchanging media.

[0013] In yet a further embodiment of the present invention, each chamber may include redirection members that redirect heat exchanging media in a particular direction through the chamber.

[0014] In another embodiment of the present invention, the inner surface of the tube may feature indentations to increase the surface area. Also, in yet another embodiment of the present invention, the inner surface of the chamber may also feature indentations to increase the surface area. In a further embodiment of the present invention, the redirection member may also feature indentations.

[0015] In other embodiments of the present invention, the tube and chamber combination may be repeated, and based on a particular application, there may be multiple tube and chamber assembly rows. Several of the tube and chamber units may be attached to a header or a manifold. There may be a plurality of tube and chamber units arranged in a row that are attached to a header or a manifold to enhance the overall performance of the heat exchanger.

[0016] In some embodiments, the chamber is of a greater diameter than the inlet and the outlet of the chamber. In other embodiments, the chamber is of a greater diameter than the inlet of the chamber, but may be the same diameter as the outlet. Alternatively, in yet other embodiments, the chamber may be of a greater diameter than the outlet of the chamber, but may be the same diameter as the inlet.

[0017] In yet some other embodiments, the chamber has at least one greater dimension than the tube. For instance, the chamber may have a greater fluid capacity, circumference, or surface area. The ratio of a particular dimension between the tube and the chamber may be 1:1.1; 1:1.5; or any other suitable ratio.

[0018] The tube and the chamber may be made of aluminum, either with cladding or without cladding. The tube and chamber may also be made of stainless steel, copper or other ferrous or non-ferrous materials. The tube and chamber may also be a plastic material or other composite materials.

[0019] The tube and chamber may be manufactured by stamping, cold forging, or machining. The tube and chamber may be manufactured as one piece or may be manufactured as two separate pieces.

[0020] Other features and advantages of the present invention will be readily appreciated, as the same becomes better understood after reading the subsequent description taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

- [0021] FIG. 1 is a perspective view of a tube and a chamber illustrated in operational relationship with a heat exchanger according to embodiments of the present invention;
- [0022] FIGS. 2A through 2B illustrate two embodiments of the present invention;
- [0023] FIG. 2C is a perspective view of a tube and chamber with a medium-directing insert;
- [0024] FIG. 3 is a view of a redirect chamber with redirection members;
- [0025] FIGS. 4A through 4E illustrate various embodiments of the tube;
- [0026] FIGS. 5A through 5D illustrate various embodiments of the redirect chamber;
- [0027] FIG. 6A and 6B are different views of the invention heat exchanger formed by stacked plates;
- [0028] FIG. 7 is a cross-section of an embodiment of the invention surrounded by a compartment;
- [0029] FIG. 8A and 8B illustrate an embodiment of the invention illustrating a type of redirection member;
- [0030] FIGS. 9A and 9B illustrate another embodiment of the present invention;
- [0031] FIGS. 10A and 10B illustrate yet another embodiment of the present invention;
- [0032] FIGS. 11A and 11B illustrate a further embodiment of the present invention;
- [0033] FIG. 12 illustrates another embodiment of the redirection chamber; and
- [0034] FIGS. 13A and 13B illustrate an embodiment using unsecured redirection members in the redirection chamber.

DETAILED DESCRIPTION

[0035] Referring to the drawings and in particular FIG. 1, an embodiment of a heat exchanger **100** is shown. The heat exchanger **100** includes a manifold **200** matingly engaged to free ends of tubes **10** that are brazed together to redirect chambers **20**. As shown in FIG. 1, the redirect chambers **20** have a greater fluid capacity than the tubes **10**. Heat exchange media **50** flows from the outlet **210** of the manifold **200** into the inlet **11** of the tube **10**. The heat exchange medium **50** passes through the outlet **19** of the tube **10** into the inlet **21** of the redirect chamber **20**. The heat exchange media **50** then flows out an outlet **29** of the redirect chamber **20**. The process of going from a tube **10** to a redirect chamber **20** may repeat several times until the heat exchange media **50** is received by another manifold. There may also be several rows of the tube **10** and redirect chamber **20** combinations. Also, one embodiment may allow for just one tube **10** and one redirect chamber **20**. Throughout the transport of the heat exchange media **50** through the heat exchanger **100**, the heat from the heat exchange media **50** is transferred to the environment outside of the heat exchanger **100**. Although not meant to be limiting, common heat exchange media known in the art includes various refrigerants (i.e., R-134A), carbon dioxide, butane, oils, gases (e.g., air), water, and mixtures of water and other coolants.

[0036] In another embodiment of the heat exchanger **100**, the heat exchanger **100** may be used in a reversed method. Instead of the heat exchanger **100** being used in an environment where heat is transferred from the heat exchange media **50** to the surrounding environment of the heat exchanger **100**, the heat exchanger **100** may be used to increase the temperature of the heat exchange media **50** flowing inside the present invention. For example, water of an ambient temperature may flow through the tube **10** and the chamber **20** of the heat exchanger **100**, where the environment surrounding the heat exchanger **100** is of a higher temperature than that of the water. Continuing with this example, the heat from the environment surrounding the heat exchanger **100** is transferred to the water, thereby increasing the

temperature of the water. An example of this embodiment, which is not intended to be limiting, would be a water heater.

[0037] Referring to FIG. 2A, the inside of tube 10 is hollow, which allows for the flowing of the heat exchange medium 50. The tube 10 is mated to the redirect chamber 20. The redirect chamber 20 houses a medium-directing insert 30. The medium-directing insert 30 is positioned within the intersecting space between the tube 10 and the redirect chamber 20. The heat exchanging medium 50 flows through the tube 10 until the heat exchanging medium 50 flows into contact with the medium-directing insert 30. The medium-directing insert 30 directs the heat exchanging medium 50 into the inside of the redirect chamber 20. According to the present embodiment, the heat exchange medium 50 disperses throughout the redirect chamber 20 and heat is transferred from the heat exchange medium 50 to the redirect chamber 20.

[0038] Referring to FIG. 3, an embodiment of the redirect chamber 20 is shown. Redirection members 28 are attached to the redirect chamber 20. In this embodiment, the redirection members 28 are attached to the inner wall of the redirect chamber 20. Although not meant to be limiting, in FIG. 3, the redirection members 28 are secured at an angle. In addition, other embodiments may secure the redirection members 28 perpendicularly to the inside of the redirect chamber 20, that is, the redirection members 28 are at 90 degree angles.

[0039] Referring to FIG. 2B, the inside of tube 10 is hollow, which allows for the flowing of a heat exchange medium 50. The tube 10 is mated to the redirect chamber 20. The redirect chamber 20 houses a medium-directing insert 30. The medium-directing insert 30 is fixed within the intersecting space between the tube 10 and the redirect chamber 20. The heat exchanging medium 50 flows through the tube 10 until the heat exchanging medium 50 flows into contact with the medium-directing insert 30. The medium-directing insert 30 directs the heat exchanging medium 50 into the inside of the redirect chamber 20. According to the embodiment in FIG. 2B, redirection members 28 direct the heat exchange medium 50 in a

particular direction within the redirect chamber **20** and heat is transferred from the heat exchange medium **50** to the redirect chamber **20**.

[0040] Referring to FIG. **2C**, a perspective view of tube **10** and chamber **20** is shown. The inside of tube **10** is hollow, which allows for the flowing of the heat exchange medium **50**, the flow direction is illustrated by the arrows. The tube **10** is mated to the redirect chamber **20**. The redirect chamber **20** houses a medium-directing insert **30**. The medium-directing insert **30** is fixed within the intersecting space between the tube **10** and the redirect chamber **20**. The heat exchanging medium **50** flows through the tube **10** until the heat exchanging medium **50** flows into contact with the medium-directing insert **30**. The medium-directing insert **30** directs the heat exchanging medium **50** into the inside of the redirect chamber **20**. According to the present embodiment, the heat exchange medium **50** disperses throughout the redirect chamber **20** and heat is transferred from the heat exchange medium **50** to the redirect chamber **20**.

[0041] Referring to FIG. **4A**, the tube **10**, in the illustrated embodiment, is hollow and circular. In another embodiment, as shown in FIG. **4B**, the tube **10** is hollow and a non-circle shape. In yet another embodiment, as shown in FIG. **4C**, ribs **18**, which divide the area inside the tube **10** into smaller compartments for transferring the heat exchange media **50**, are placed inside the tube **10** to increase heat exchange performance. FIG. **4D** illustrates an embodiment of the tube **10** with inward indentations **12** and outward indentations **14**. FIG. **4E** illustrates a further embodiment of the tube **10** with tube fins **16** shrouding the outer surface of the tube **10**.

[0042] Referring to FIG. **5A**, redirect chamber **20**, in the illustrated embodiment, is hollow and circular. In another embodiment, as shown in FIG. **5B**, the redirect chamber **20** is hollow and a non-circular shape. FIG. **5C** illustrates an embodiment of the redirect chamber **20** with inward indentations **22** and outward indentations **24**. FIG. **5D** illustrates a further embodiment of the redirect chamber **20** with chamber fins **26** shrouding the outer surface of

the redirect chamber **20**. Although not meant to be limiting, the diameter of the inlet **21** of the redirect chamber **20** will be smaller than the overall diameter of the redirect chamber **20**.

Also, the diameter of the outlet **29** of the redirect chamber **20** will be smaller than the overall diameter of the redirect chamber **20**.

[0043] The tube **10** embodiments shown in FIGS. **4A – 4E** may be mated in various combinations with the redirect chamber **20** embodiments shown in FIGS. **5A – 5D**.

Additional tube fins **16** and chamber fins **26** or other materials can be attached to the outside surface of the tube **10** or the redirect chamber **20**, and the additional material does not have to be attached for the full length of the tube **10**. Tubes **10** and redirect chambers **20** near the inlet side of the invention may feature additional material. Other embodiments of the tubes and chambers not pictured may also be combined, and the invention is not limited to the embodiments described.

[0044] Referring to FIGS. **6A** and **6B**, another embodiment of a heat exchanger is shown. A plate **600** contains at least one hole **610** that goes through the thickness of the plate **600**. On one side of the plate **600**, and centered on the hole **610**, a cavity **620**, which is of a larger diameter than the diameter of the hole **610**, is created in the plate **600** without going completely through the plate **600**. One end of a medium-directing insert **30** is connected to an outer edge of the cavity **620**, and the opposite end of the medium-directing insert **30** is connected to the inner edge of the cavity **620**. When a plate **600a** is stacked onto another plate **600b**, and the respective holes **610** are aligned, the holes **610** create a tube-like segment and the cavities **620** create a chamber. Heat exchange media **50** may flow through the hole **610** into the cavity **620** where the heat exchange media **50** encounters the medium-directing insert **30** that redirects the heat exchange media **50** into the cavity **620**, the flow direction is illustrated by the arrows.

[0045] Referring to FIG. **7**, another embodiment of a heat exchanger is shown. A compartment **700** surrounds a tube and chamber combination **710**. The compartment **700** has

an inlet **701** and an outlet **702**. The compartment **700** directs an air flow **750** around a tube and chamber combination **710** while a heat exchange medium **50** flows through the tube and chamber combination **710**. According to this embodiment, the transfer of heat is further facilitated by the movement of the air flow **750** across the tube and chamber combination **710**.

[0046] Referring to FIGS. **8A** and **8B**, one embodiment of the invention is shown. A chamber **20** is directly connected to another chamber **20**, each of which house a redirection member **28**. In each chamber **20**, the redirection member **28** redirects heat exchange media **50** throughout the chamber **20**. The arrows illustrate how the heat exchange media **50** may be redirected according to the embodiment as shown.

[0047] Referring to FIG. **9A**, a cross-section of another embodiment of the invention is shown. A chamber **20** is connected to a tube **10** that is connected to another chamber **20**. Each chamber **20** in the present embodiment houses a redirection member **28**, which in this embodiment attaches to the inner surface of the chamber **20**. The redirection member **28** allows passage of the heat exchange media through multiple holes **90** in the redirection member **28**. The arrows illustrate how the heat exchange media **50** may be redirected according to the embodiment as shown. Referring to FIG. **9B**, an embodiment of a redirection member **28** is shown. The redirection member **28** contains openings **90** that allow for the passage of heat exchange media **50**.

[0048] Referring to FIG. **10A**, a cross-section of yet another embodiment of the invention is shown. A chamber **20** is connected to a tube **10** that is connected to another chamber **20**. Each chamber **20** in the present embodiment may house a redirection member **28**, which in this embodiment attaches at certain points to the inner surface of the chamber **20**, which leaves openings **91** along the inner surface of the chamber **20**. The redirection member **28** allows passage of the heat exchange media **50** through these openings **91** in the redirection member **28**. The arrows illustrate how the heat exchange media **50** may be redirected

according to the embodiment as shown. Referring to FIG. 10B, an embodiment of a redirection member 28 is shown. The redirection member 28 contains openings 91 that allow for the passage of heat exchange media 50 through the redirection member 28.

[0049] Referring to FIG. 11A, a cross-section of yet another embodiment of the invention is shown. The tube 10 is mated to the redirect chamber 20. The redirect chamber 20 houses a medium-directing insert 30. The medium-directing insert 30 is fixed within the intersecting space between the tube 10 and the redirect chamber 20. A chamber 20 is connected to a tube 10 that is connected to another chamber 20. Each chamber 20 in the present embodiment have indentations 92 in the chamber walls. The arrows illustrate how the heat exchange media 50 may be directed according to the embodiment as shown. Referring to FIG. 11B, an embodiment of a wall of a chamber 20 is shown. The wall of the chamber 20 contains indentations 92 that redirect and mix the passage of heat exchange media 50 as it flows through the chamber 20.

[0050] Referring to FIG. 12, the redirect chamber 20, in combination with any of the above embodiments, does not have to be cylinder-shaped, other embodiments may be shaped like a cube (with various ratios of height, length, and width dimensions), or other geometric shapes.

[0051] FIGS. 13A and 13B illustrate an embodiment of the invention where the redirection members 28 are not secured to an inside surface of the chamber 20. The arrows illustrate how the heat exchange media 50 may be directed according to the embodiment as shown. By way of example, the redirection members 28 could be a ball bearing or combination of multiple ball bearings that participate in a mixing and churning process within the chamber 20, as shown by the arrows in FIG. 13, which aids in the heat exchange process. The invention is not limited to using ball bearings in the chamber, as other unsecured redirection members may be used alone or in combination with one another for achieving

greater heat exchange efficiency, such as a redirection member that is moved into a particular position by contact from heat exchange media.

[0052] The chamber generally has at least one greater dimension than the tube. For instance, the chamber may have a greater fluid capacity, circumference, or surface area. The ratio of a particular dimension between the tube and the chamber may be 1:1.1, 1:1.5, or any other ratio.

[0053] The tube and the chamber may be made of aluminum, either with cladding or without cladding. The tube and chamber may also be made of stainless steel, copper or other ferrous or non-ferrous materials. The tube and chamber may also be a plastic material or other composite materials. Likewise, the redirect member may be made of aluminum, either with cladding or without cladding. The redirect member may also be made of stainless steel, copper or other ferrous or non-ferrous materials. The redirect member may also be a plastic material or other composite materials. Also, an embodiment of the present invention allows for the tube to be made of a different material than the material used for the chamber, and the redirect members may be made of a different material than the material used for the chamber and tube. If more than one redirect member is used in an embodiment of the invention, one redirect member may be made of a different material than another redirect member. The redirect members may also be of different shapes than one another. Also, in embodiments that use more than one redirect member, one or more of the redirect members may be secured to the inside wall of the chamber and the other redirect members may be free to move around inside the redirect chamber.

[0054] The tube and chamber may be manufactured by stamping, cold forging, or machining. The tube and chamber may be manufactured as one piece or may be manufactured as two separate pieces.

[0055] The present invention has been described in an illustrative manner. The term “redirect” means to change the direction or course of, or impede the progress of, the heat

exchange media, even if by the smallest difference in angle or velocity. It is to be understood that the terminology which has been used is intended to be in the nature of words of description rather than of limitation.

[0056] Many modifications and variations of the present invention are possible in light of the above teachings. Therefore, within the scope of the appended claims, the present invention may be practiced other than as specifically described.

WHAT IS CLAIMED IS:

1. A heat exchange chamber comprising:
 - an inlet for receiving a heat exchange medium flowing in a first flow
 - 5 direction in an initial line of flow;
 - a plurality of walls defining a chamber interior which is in fluid communication with the inlet;
 - a medium directing member, having an inclined surface facing the inlet, disposed at least partially within the chamber interior
 - 10 near the inlet to divert the medium from the initial line of flow to a second flow direction which is substantially perpendicular to the first flow direction so that the medium disperses within the chamber interior; and
 - an outlet in fluid communication with the chamber interior for out-
 - 15 putting the medium, the outlet having an opening rearwardly facing the first flow direction,
 - wherein the chamber is configured to cause the medium, subsequently to flowing in the first flow direction, to flow within the chamber interior in first and second generally semi-circular
 - 20 flow paths, each of which travels at least partially around a respective line segment extending from the inlet in the first flow direction and lies in a plane substantially perpendicular to the first flow direction, the first and second flow paths originating from a same region within the chamber interior and
 - 25 flowing in opposing generally semi-circular routes at least partially around the respective line segment.
2. The heat exchange chamber according to claim 1 wherein the chamber interior has a generally cylindrical shape.

3. The heat exchange chamber according to claim 1, wherein at least a portion of at least one of the chamber walls extends beyond the chamber interior in a radial direction.
- 5 4. The heat exchange chamber according to claim 1 further including at least one redirection member, disposed within the chamber interior, for assisting dispersion of the medium within the chamber interior.
- 10 5. The heat exchange chamber according to claim 4 wherein the redirection member is realized by an indentation in at least one of the chamber walls.
- 15 6. The heat exchange chamber according to claim 1, wherein the heat exchange chamber is realized by a plate, the chamber interior being formed by a cavity within the plate and the inlet being formed by a hole in the plate, the cavity being centered on the hole and having a diameter larger than a diameter of the hole.
- 20 7. A heat exchange assembly comprising:
a plurality of tube-like segments for transporting a heat exchange medium in a first flow direction in an initial line of flow; and
a plurality of heat exchange chambers, a heat exchange chamber being coupled between adjacent pairs of the tube-like segments, each of the heat exchange chambers including:
25 an inlet for receiving the medium flowing in the first flow direction in the initial line of flow from a first one of the tube-like segments in an adjacent pair;
a plurality of walls defining a chamber interior which is in fluid communication with the inlet;

- 5 a medium directing member, having an inclined surface facing
the inlet, disposed at least partially within the chamber
interior near the inlet to divert the medium from the
initial line of flow to a second flow direction which is
substantially perpendicular to the first flow direction so
that the medium disperses within the chamber interior;
and
- 10 an outlet in fluid communication with the chamber interior for
outputting the medium in the first flow direction in the
initial line of flow to the second one of the tube-like
segments in the adjacent pair,
- 15 wherein the chamber is configured to cause the medium, sub-
sequently to flowing in the first flow direction, to flow
within the chamber interior in first and second generally
semi-circular flow paths, each of which travels at least
partially around a respective line segment extending
from the inlet in the first flow direction and which lies
in a plane substantially perpendicular to the first flow
direction, the first and second flow paths originating
20 from a same region within the chamber interior and
flowing in opposing generally semi-circular routes at
least partially around the respective line segment.
- 25 8. The heat exchange assembly according to claim 7 wherein at least a
portion of at least one of the chamber walls extends beyond the
chamber interior in a radial direction.
9. A heat exchanger comprising:
a first reservoir having a plurality of outlets;

a second reservoir having a plurality of inlets, each of the inlets in the second reservoir corresponding to one of the outlets in the first reservoir; and

a plurality of heat exchange assemblies, each of the assemblies including:

a plurality of sets of tube-like segments for transporting a heat exchange medium from the first reservoir to the second reservoir, each set of the tube-like segments being disposed between one of the outlets of the first reservoir and the corresponding inlet in the second reservoir for transporting the medium in a first flow direction in respective initial lines of flow; and

a plurality of heat exchange chambers, a heat exchange chamber being coupled between adjacent pairs of the tube-like segments in a respective initial line of flow, each of the heat exchange chambers including:

a chamber inlet for receiving the medium flowing in the first flow direction in the respective initial line of flow from a first one of the tube-like segments in an adjacent pair;

a plurality of walls defining a chamber interior which is in fluid communication with the chamber inlet;

a medium directing member, having an inclined surface facing the chamber inlet, disposed at least partially within the chamber interior near the chamber inlet to divert the medium from the respective initial line of flow to a second flow direction which is substantially perpendicular to the first

flow direction so that the medium disperses within
 the chamber interior; and
 a chamber outlet in fluid communication with the cham-
 ber interior for outputting the medium in the first
 5 flow direction in the respective initial line of flow
 to the second one of the tube-like segments in the
 adjacent pair,
 wherein the chamber is configured to cause the medium,
 subsequently to flowing in the first flow direction,
 10 to flow within the chamber interior in first and
 second generally semi-circular flow paths, each of
 which travels at least partially around a respective
 line segment extending from the chamber inlet in
 the first flow direction and which lies in a plane
 15 substantially perpendicular to the first flow direc-
 tion, the first and second flow paths originating
 from a same region within the chamber interior
 and flowing in opposing generally semi-circular
 routes at least partially around the respective line
 20 segment.

10. The heat exchange chamber according to claim 1 wherein the inlet and outlet are axially aligned along the initial line of flow.
- 25 11. The heat exchange assembly according to claim 7 wherein the chamber interior has a generally cylindrical shape.
12. The heat exchange assembly according to claim 7 further including at least one redirection member, disposed within the chamber inte-

rior, for assisting dispersion of the medium within the chamber interior.

- 5 13. The heat exchange assembly according to claim 12 wherein the redirection member is realized by an indentation in at least one of the chamber walls.
- 10 14. The heat exchanger according to claim 9 wherein the chamber interior has a generally cylindrical shape.
- 15 15. The heat exchanger according to claim 9 wherein at least a portion of at least one of the chamber walls extends beyond the chamber interior in a radial direction.
- 20 16. The heat exchanger according to claim 9 further including at least one redirection member, disposed within the chamber interior, for assisting dispersion of the medium within the chamber interior.
- 25 17. The heat exchanger according to claim 16 wherein the redirection member is realized by an indentation in at least one of the chamber walls.
18. A heat exchange chamber comprising:
an inlet for receiving a heat exchange medium flowing in a first flow direction in an initial line of flow;
a plurality of walls defining a chamber interior which is in fluid communication with the inlet;
an outlet in fluid communication with the chamber interior; and

5 a medium directing member disposed at least partially within the chamber interior, the medium directing member having a surface which faces the inlet and which has an incline relative to the first flow direction to divert the medium from the initial line of flow so that the medium disperses within the chamber interior,

10 wherein the chamber is configured to cause the medium dispersed within the chamber to flow in at least two generally semi-circular flow paths and thereafter to flow through the outlet in the first flow direction.

15 19. The heat exchange chamber according to claim 18 wherein the surface of the medium directing member is inclined relative to the first flow direction such that the medium is diverted to flow in a second flow direction which is substantially perpendicular to the first flow direction.

20 20. The heat exchange chamber according to claim 18 wherein the inlet and the outlet are axially aligned along the initial line of flow.

21. The heat exchange chamber according to claim 18 wherein the chamber interior has a generally cylindrical shape.

25 22. The heat exchange chamber according to claim 18 wherein at least a portion of at least one of the chamber walls extends beyond the chamber interior in a radial direction.

23. The heat exchange chamber according to claim 18 further including at least one redirection member, disposed within the chamber inte-

rior, for assisting dispersion of the medium within the chamber interior.

24. The heat exchange chamber according to claim 23 wherein the
5 redirection member is realized by an indentation in at least one of the chamber walls.
25. A heat exchange assembly comprising:
a plurality of tube-like segments for transporting a heat exchange
10 medium in a first flow direction in an initial line of flow; and
a plurality of heat exchange chambers, a heat exchange chamber
being coupled between adjacent pairs of the tube-like seg-
ments, each of the heat exchange chambers including:
an inlet for receiving the medium flowing in the first flow
15 direction in the initial line of flow from a first one of the
tube-like segments in an adjacent pair;
a plurality of walls defining a chamber interior which is in
fluid communication with the inlet;
an outlet in fluid communication with the chamber interior for
20 outputting the medium; and
a medium directing member disposed at least partially within
the chamber interior, the medium directing member
having a surface which faces the inlet and which has an
incline relative to the first flow direction to divert the
25 medium from the initial line of flow so that the medium
disperses within the chamber interior,
wherein the chamber is configured to cause the medium dis-
persed within the chamber to flow in at least two gener-
ally semi-circular flow paths and thereafter to flow

through the outlet in the first flow direction in the initial line of flow to the second one of the tube-like segments in the adjacent pair.

- 5 26. The heat exchange assembly according to claim 25 wherein the surface of the medium directing member is inclined relative to the first flow direction such that the medium is diverted to flow in a second flow direction which is substantially perpendicular to the first flow direction.
- 10
27. The heat exchange assembly according to claim 25 wherein the chamber interior has a generally cylindrical shape.
- 15 28. The heat exchange assembly according to claim 25 wherein at least a portion of at least one of the chamber walls extends beyond the chamber interior in a radial direction.
- 20 29. The heat exchange assembly according to claim 25 further including at least one redirection member, disposed within the chamber interior, for assisting dispersion of the medium within the chamber interior.
- 25 30. The heat exchange assembly according to claim 29 wherein the redirection member is realized by an indentation in at least one of the chamber walls.
31. A heat exchanger comprising:
a first reservoir having a plurality of outlets;

a second reservoir having a plurality of inlets, each of the inlets in the second reservoir corresponding to one of the outlets in the first reservoir; and

a plurality of heat exchange assemblies, each of the assemblies including:

a plurality of sets of tube-like segments for transporting a heat exchange medium from the first reservoir to the second reservoir, each set of the tube-like segments being disposed between one of the outlets of the first reservoir and the corresponding inlet in the second reservoir for transporting the medium in a first flow direction in respective initial lines of flow; and

a plurality of heat exchange chambers, a heat exchange chamber being coupled between adjacent pairs of the tube-like segments in a respective initial line of flow, each of the heat exchange chambers including:

a chamber inlet for receiving the medium flowing in the first flow direction in the respective initial line of flow from a first one of the tube-like segments in an adjacent pair;

a plurality of walls defining a chamber interior which is in fluid communication with the chamber inlet; a chamber outlet in fluid communication with the chamber interior for outputting the medium; and

a medium directing member disposed at least partially within the chamber interior, the medium directing member having a surface which faces the chamber inlet and which has an incline relative to the first flow direction to divert the medium from the

initial line of flow so that the medium disperses within the chamber interior, wherein the chamber is configured to cause the medium dispersed within the chamber to flow in at least two generally semi-circular flow paths and thereafter to flow through the chamber outlet in the first flow direction in the initial line of flow to the second one of the tube-like segments in the adjacent pair.

10

32. The heat exchanger according to claim 31 wherein the surface of the medium directing member is inclined relative to the first flow direction such that the medium is diverted to flow in a second flow direction which is substantially perpendicular to the first flow direction.

15

33. The heat exchanger according to claim 31 wherein the chamber interior has a generally cylindrical shape.

20

34. The heat exchanger according to claim 31 wherein at least a portion of at least one of the chamber walls extends beyond the chamber interior in a radial direction.

25

35. The heat exchanger according to claim 31 further including at least one redirection member, disposed within the chamber interior, for assisting dispersion of the medium within the chamber interior.

36. The heat exchanger according to claim 35 wherein the redirection member is realized by an indentation in at least one of the chamber walls.

37. A heat exchange chamber comprising:
an inlet for receiving a heat exchange medium flowing in a first flow
direction in an initial line of flow;
a plurality of walls defining a chamber interior which is in fluid
communication with the inlet;
an outlet in fluid communication with the chamber interior; and
a medium directing member disposed at least partially within the
chamber interior, the medium directing member having a first
surface which faces the inlet and a second surface which faces
the outlet, the first surface having an incline to divert the
medium from the first flow direction to a second flow direc-
tion, the chamber being configured to cause the medium to
flow within the chamber interior and return to the second flow
direction into contact with the second surface of the medium
directing member, the second surface having a decline to
divert the medium from the second flow direction through the
outlet in the first flow direction,
wherein the chamber is configured to cause the medium to flow
within the chamber interior in first and second generally semi-
circular flow paths.
38. The heat exchange chamber according to claim 37 wherein the first
surface of the medium directing member is inclined relative to the
first flow direction such that the second flow direction is substan-
tially perpendicular to the first flow direction.
39. The heat exchange chamber according to claim 37 wherein the inlet
and the outlet are axially aligned along the initial line of flow.

40. The heat exchange chamber according to claim 37 wherein the chamber interior has a generally cylindrical shape.
41. The heat exchange chamber according to claim 37 wherein at least a portion of at least one of the chamber walls extends beyond the chamber interior in a radial direction.
42. The heat exchange chamber according to claim 37 further including at least one redirection member, disposed within the chamber interior, for directing flow of the medium within the chamber interior.
43. The heat exchange chamber according to claim 42 wherein the redirection member is realized by an indentation in at least one of the chamber walls.
44. A heat exchange assembly comprising:
a plurality of tube-like segments for transporting a heat exchange medium in a first flow direction in an initial line of flow; and
a plurality of heat exchange chambers, a heat exchange chamber being coupled between adjacent pairs of the tube-like segments, each of the heat exchange chambers including:
an inlet for receiving the medium flowing in the first flow direction in the initial line of flow from a first one of the tube-like segments in an adjacent pair;
a plurality of walls defining a chamber interior which is in fluid communication with the inlet;
an outlet in fluid communication with the chamber interior for outputting the medium; and

5 a medium directing member disposed at least partially within
the chamber interior, the medium directing member
having a first surface which faces the inlet and a second
surface which faces the outlet, the first surface having
an incline to divert the medium from the first flow di-
rection to a second flow direction, the chamber being
configured to cause the medium to flow within the
chamber interior and return to the second flow direction
into contact with the second surface of the medium
10 directing member, the second surface having a decline
to divert the medium from the second flow direction
through the outlet in the first flow direction,
wherein the chamber is configured to cause the medium to
flow within the chamber interior in first and second
15 generally semi-circular flow paths.

45. The heat assembly according to claim 44 wherein the first surface of
the medium directing member is inclined relative to the first flow
direction such that the second flow direction is substantially perpen-
20 dicular to the first flow direction.

46. The heat exchange assembly according to claim 44 wherein the
chamber interior has a generally cylindrical shape.

25 47. The heat exchange assembly according to claim 44 wherein at least a
portion of at least one of the chamber walls extends beyond the
chamber interior in a radial direction.

48. The heat exchange assembly according to claim 44 further including at least one redirection member, disposed within the chamber interior, for directing flow of the medium within the chamber interior.
- 5 49. The heat exchange assembly according to claim 48 wherein the redirection member is realized by an indentation in at least one of the chamber walls.
50. A heat exchanger comprising:
- 10 a first reservoir having a plurality of outlets;
a second reservoir having a plurality of inlets, each of the inlets in the second reservoir corresponding to one of the outlets in the first reservoir; and
a plurality of heat exchange assemblies, each of the assemblies
15 including:
a plurality of sets of tube-like segments for transporting a heat exchange medium from the first reservoir to the second reservoir, each set of the tube-like segments being disposed between one of the outlets of the first reservoir
20 and the corresponding inlet in the second reservoir for transporting the medium in a first flow direction in respective initial lines of flow; and
a plurality of heat exchange chambers, a heat exchange chamber being coupled between adjacent pairs of the tube-like segments in a respective initial line of flow, each of
25 the heat exchange chambers including:
a chamber inlet for receiving the medium flowing in the first flow direction in the respective initial line of

- flow from a first one of the tube-like segments in an adjacent pair;
- a plurality of walls defining a chamber interior which is in fluid communication with the chamber inlet;
- 5 a chamber outlet in fluid communication with the chamber interior for outputting the medium; and
- a medium directing member disposed at least partially within the chamber interior, the medium directing member having a first surface which faces the
- 10 chamber inlet and a second surface which faces the chamber outlet, the first surface having an incline to divert the medium from the first flow direction to a second flow direction, the chamber being configured to cause the medium to flow
- 15 within the chamber interior and return to the second flow direction into contact with the second surface of the medium directing member, the second surface having a decline to divert the medium from the second flow direction through the
- 20 chamber outlet in the first flow direction,
- wherein the chamber is configured to cause the medium to flow within the chamber interior in first and second generally semi-circular flow paths.
- 25 51. The heat exchanger according to claim 50 wherein the first surface of the medium directing member is inclined relative to the first flow direction such that the second flow direction is substantially perpendicular to the first flow direction.

52. The heat exchanger according to claim 50 wherein the chamber interior has a generally cylindrical shape.
53. The heat exchanger according to claim 50 wherein at least a portion
5 of at least one of the chamber walls extends beyond the chamber interior in a radial direction.
54. The heat exchanger according to claim 50 further including at least
10 one redirection member, disposed within the chamber interior, for directing flow of the medium within the chamber interior.
55. The heat exchanger according to claim 54 wherein the redirection member is realized by an indentation in at least one of the chamber walls.

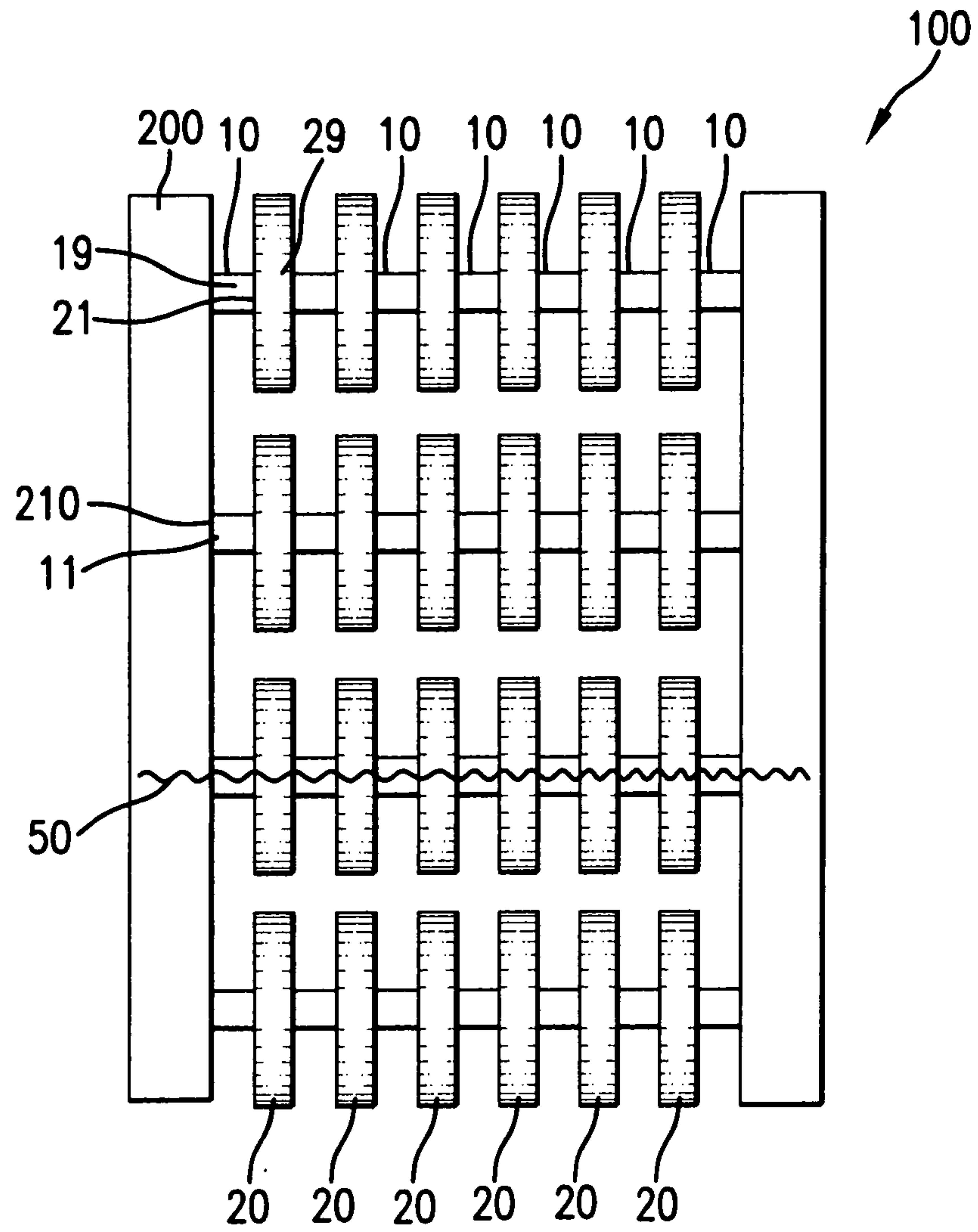


FIG. 1

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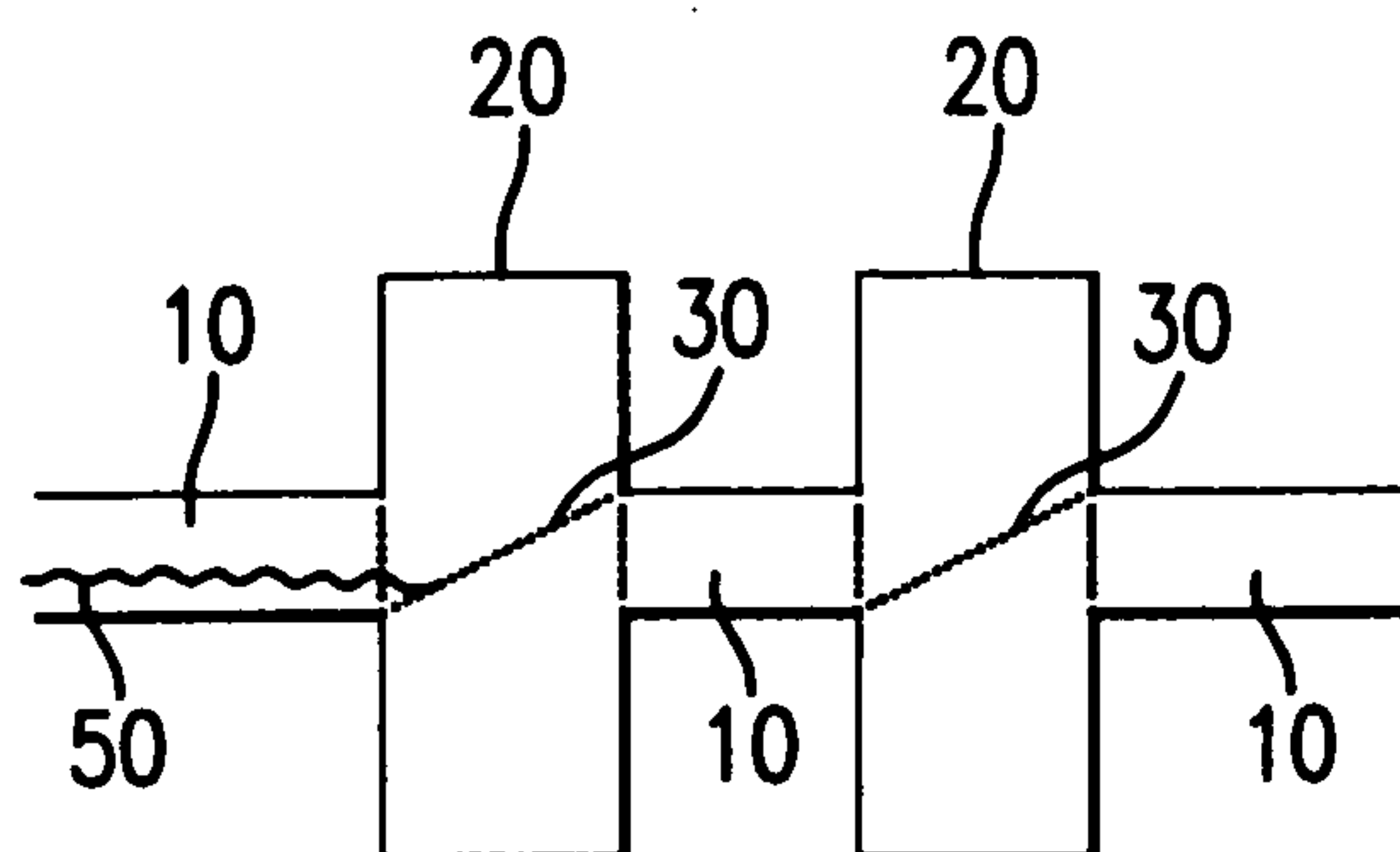


FIG. 2A

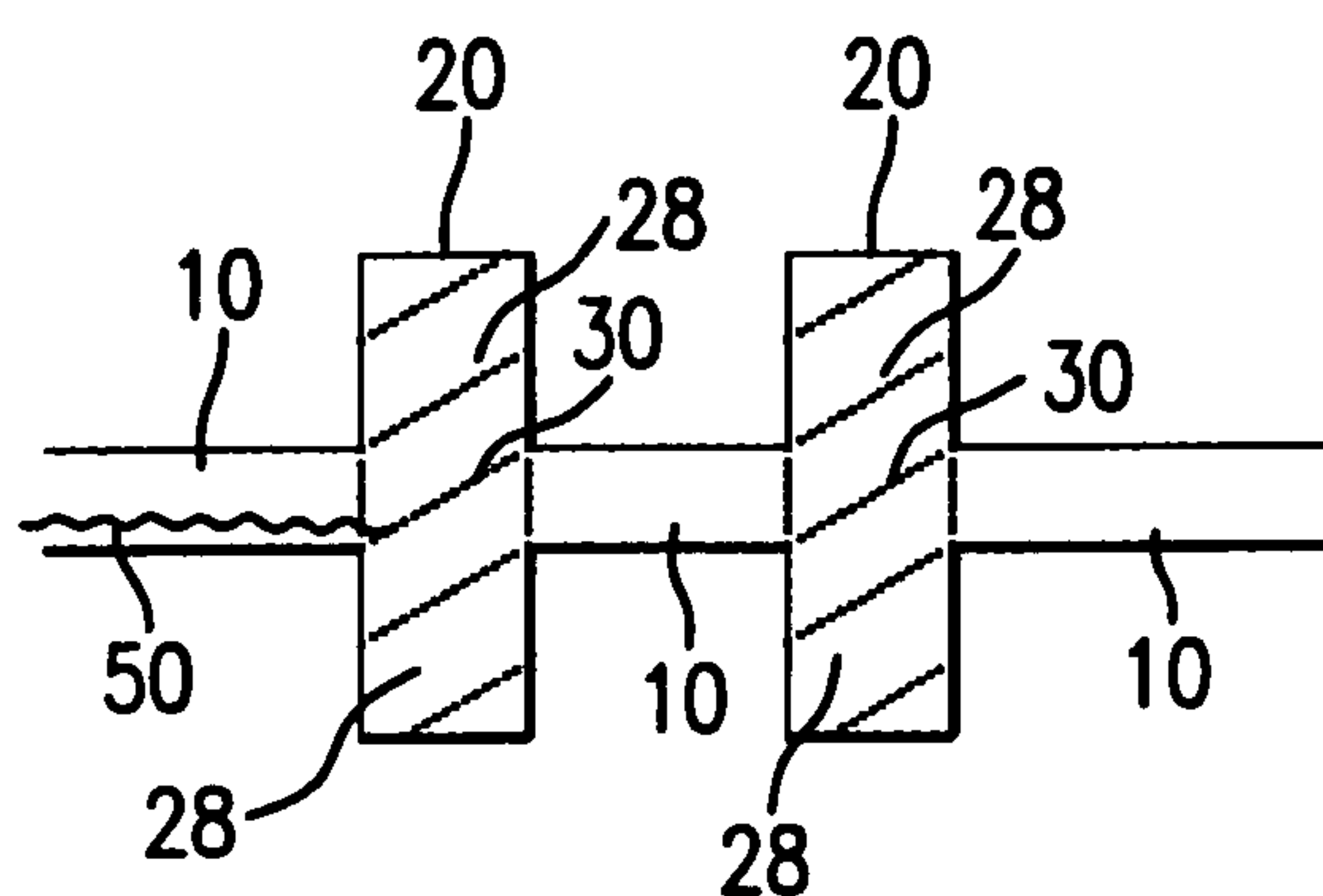


FIG. 2B

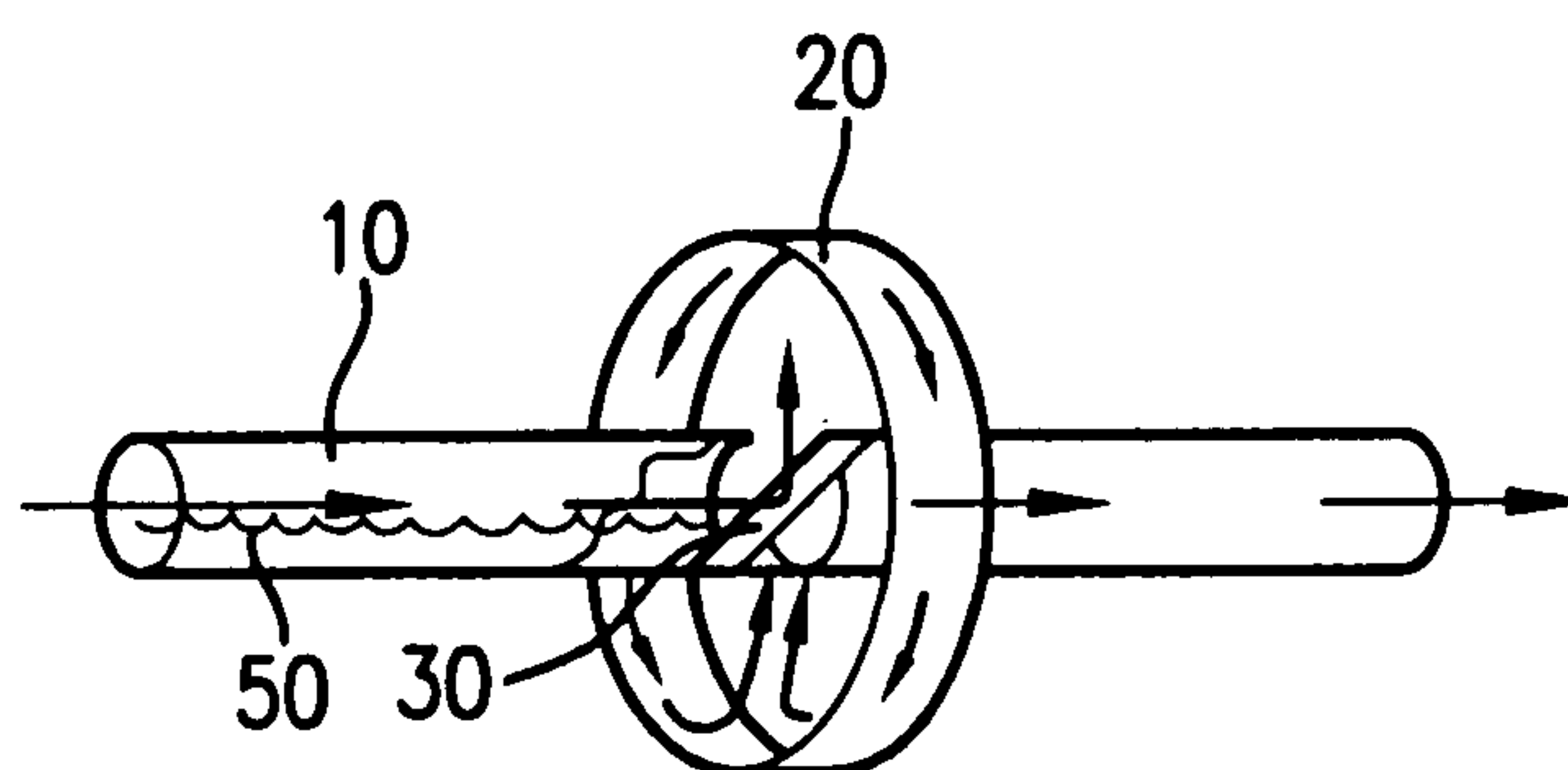


FIG. 2C

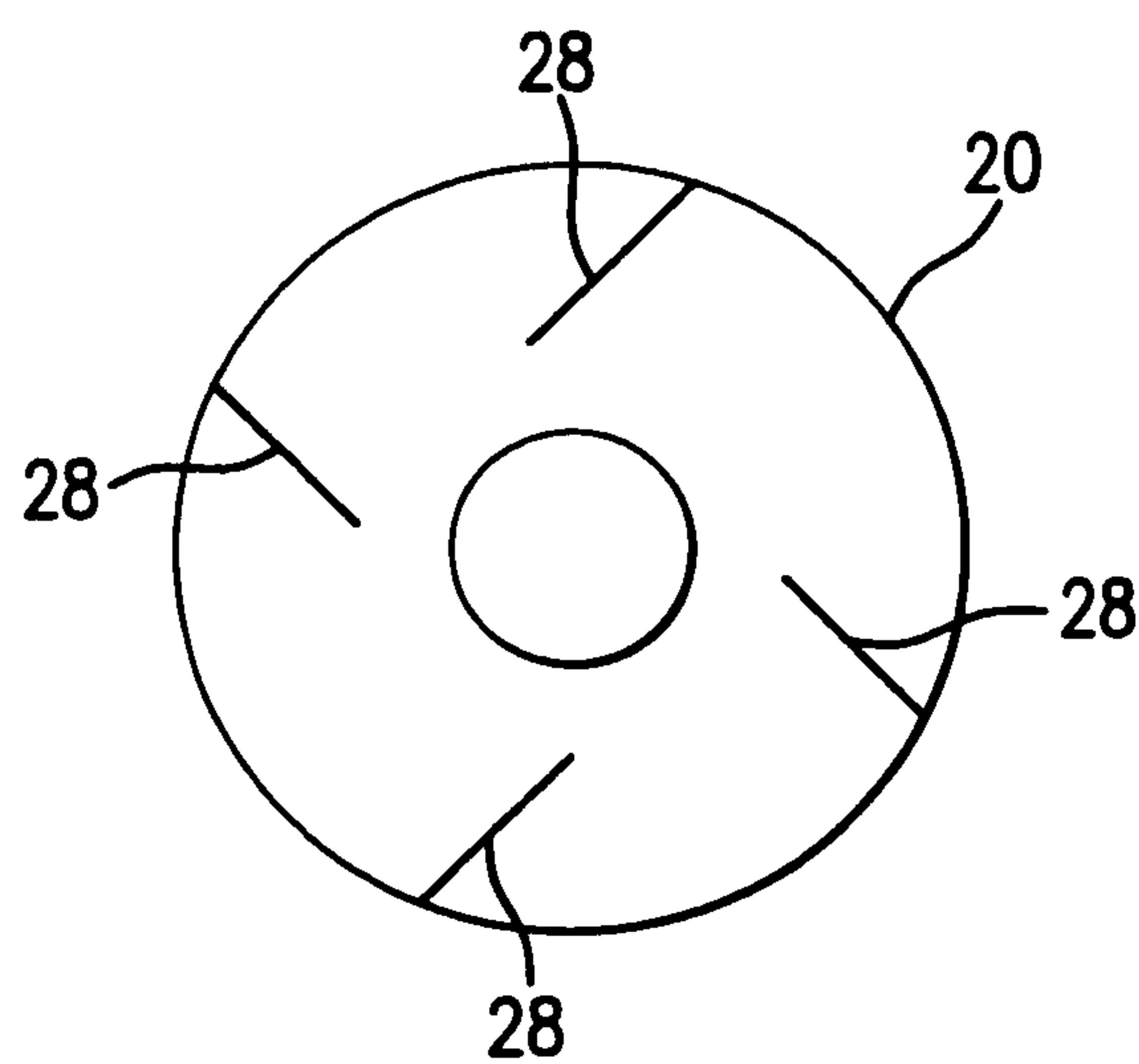


FIG. 3

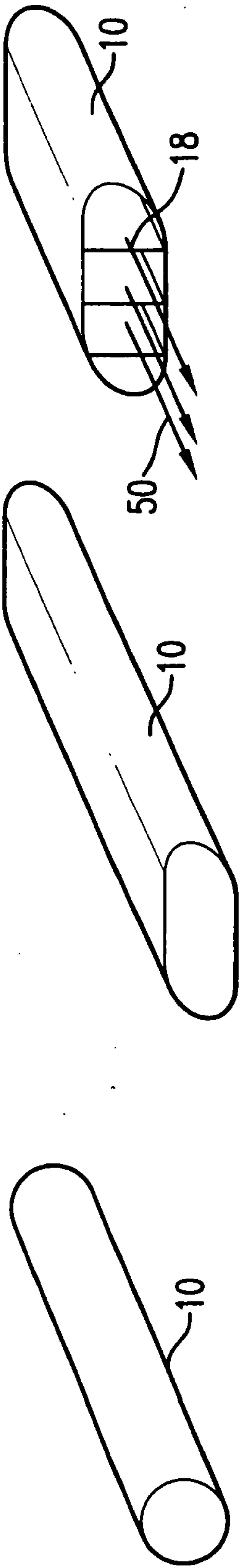


FIG. 4A

FIG. 4B

FIG. 4C

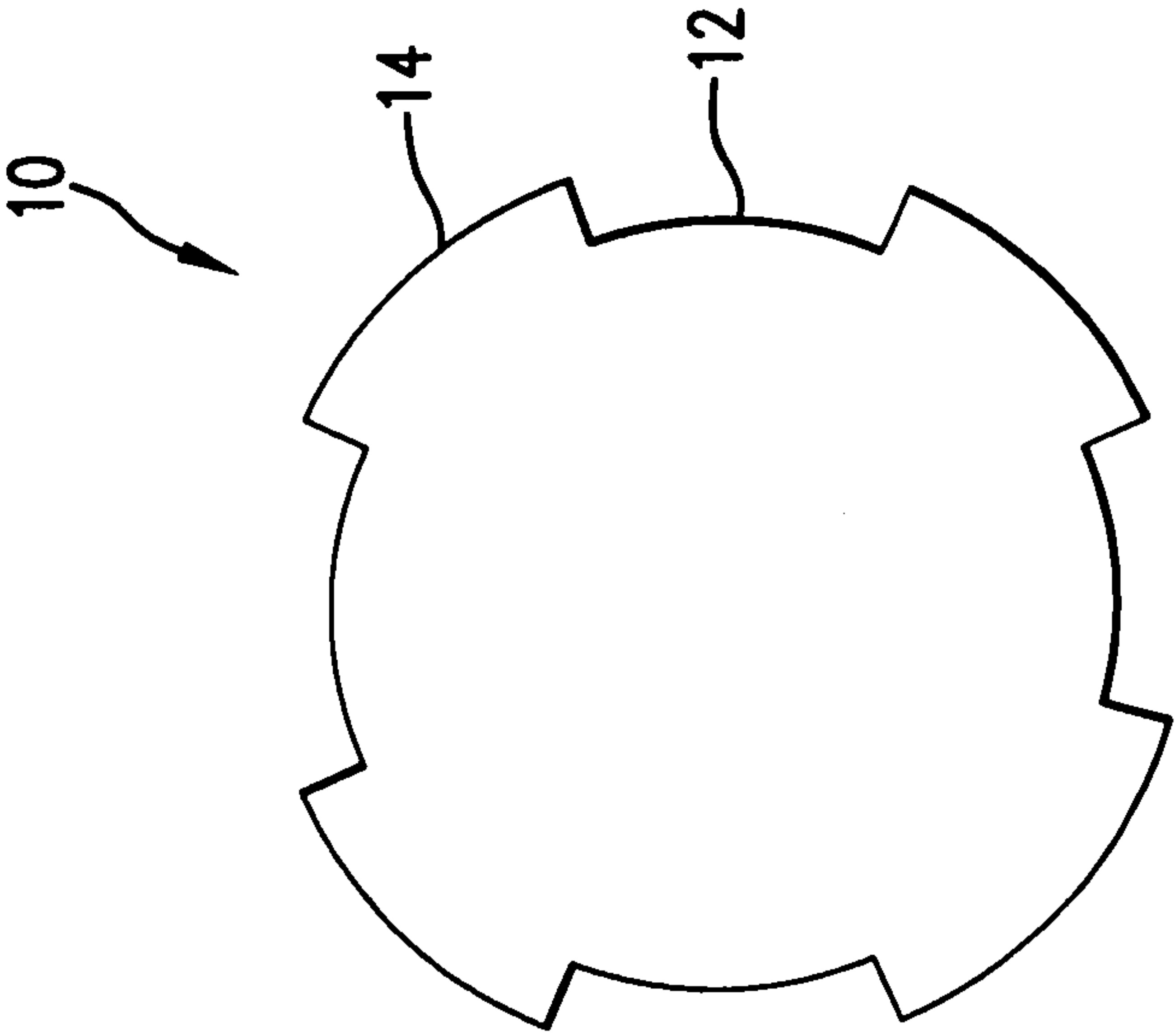


FIG. 4D

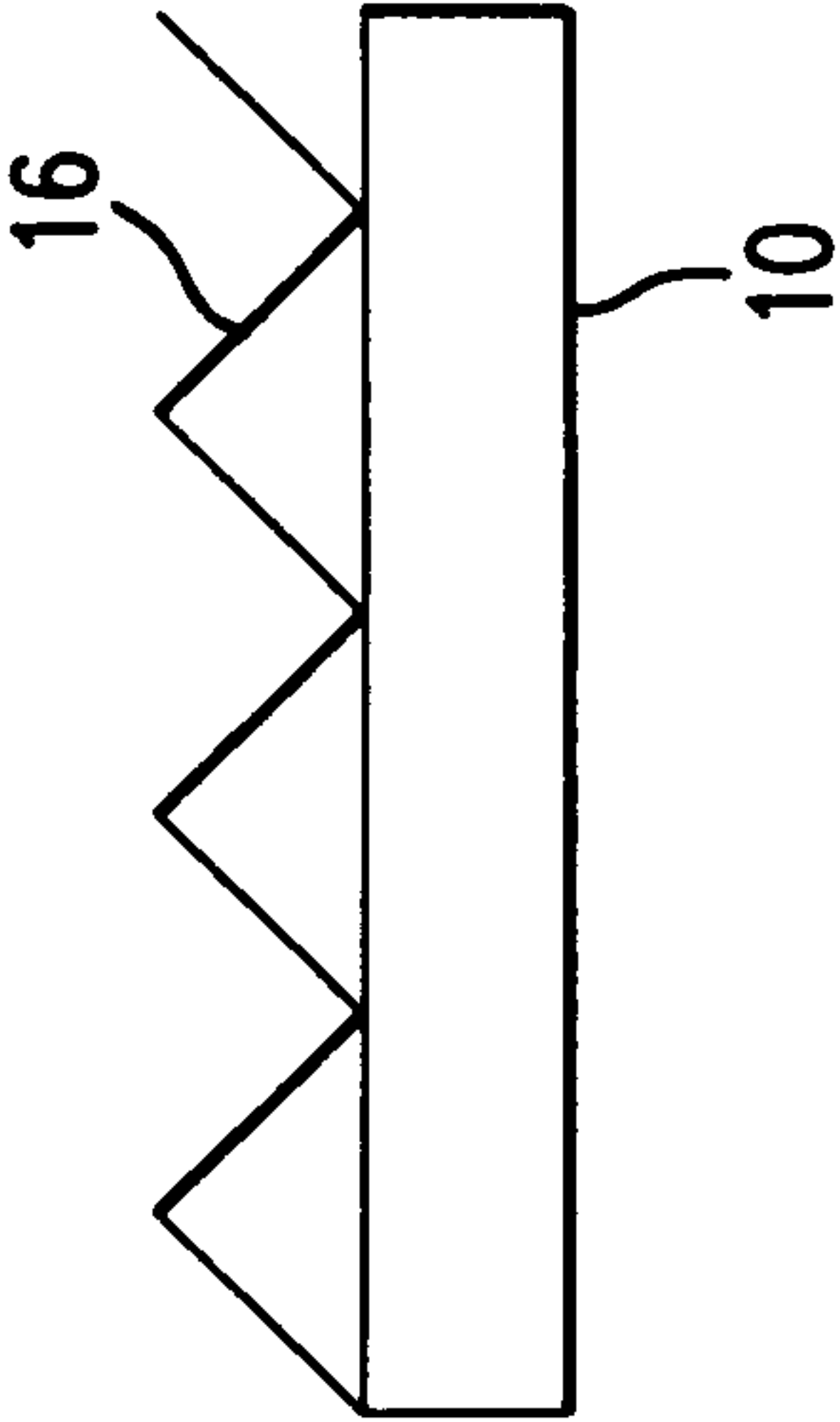


FIG. 4E

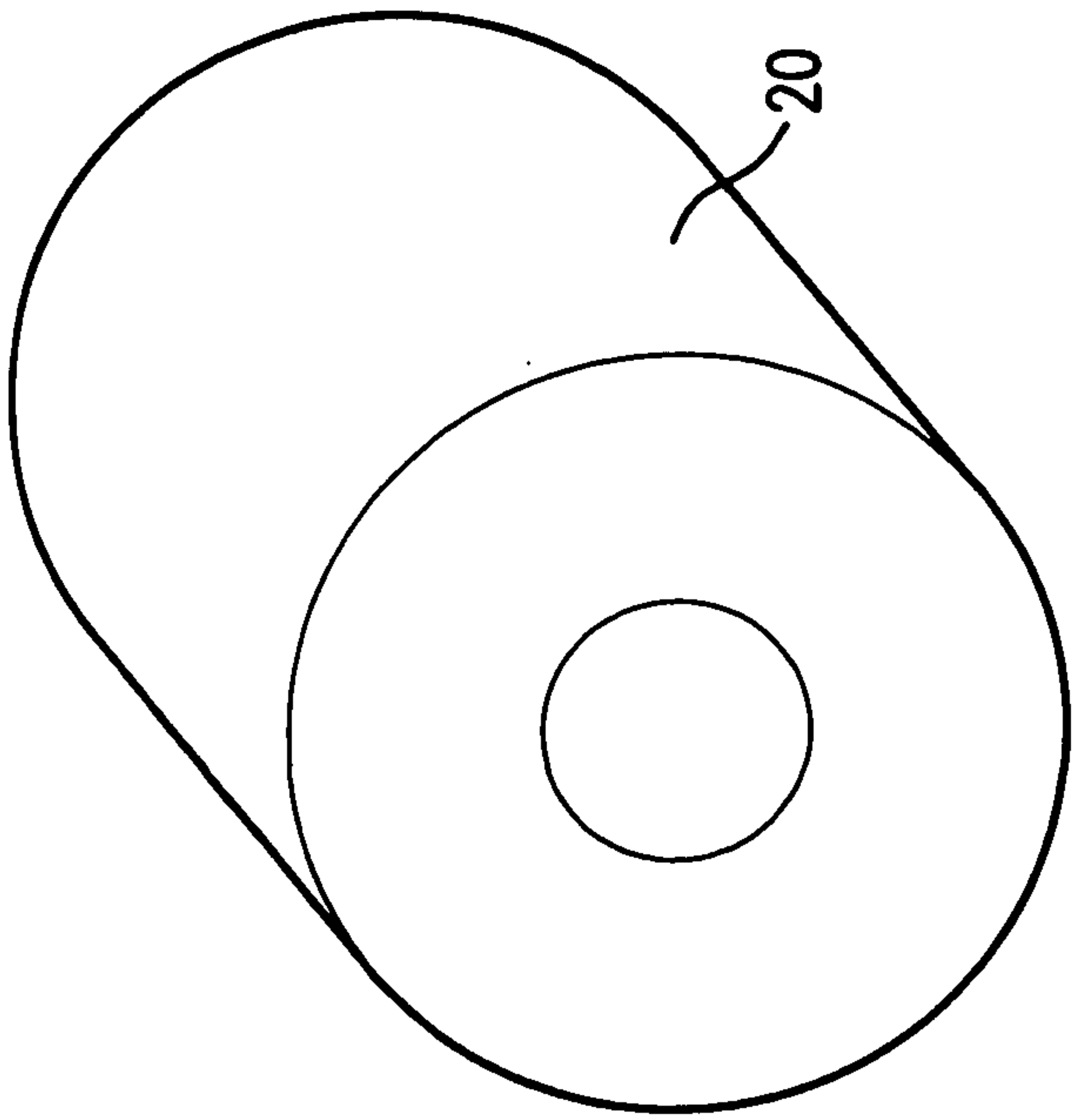


FIG. 5A

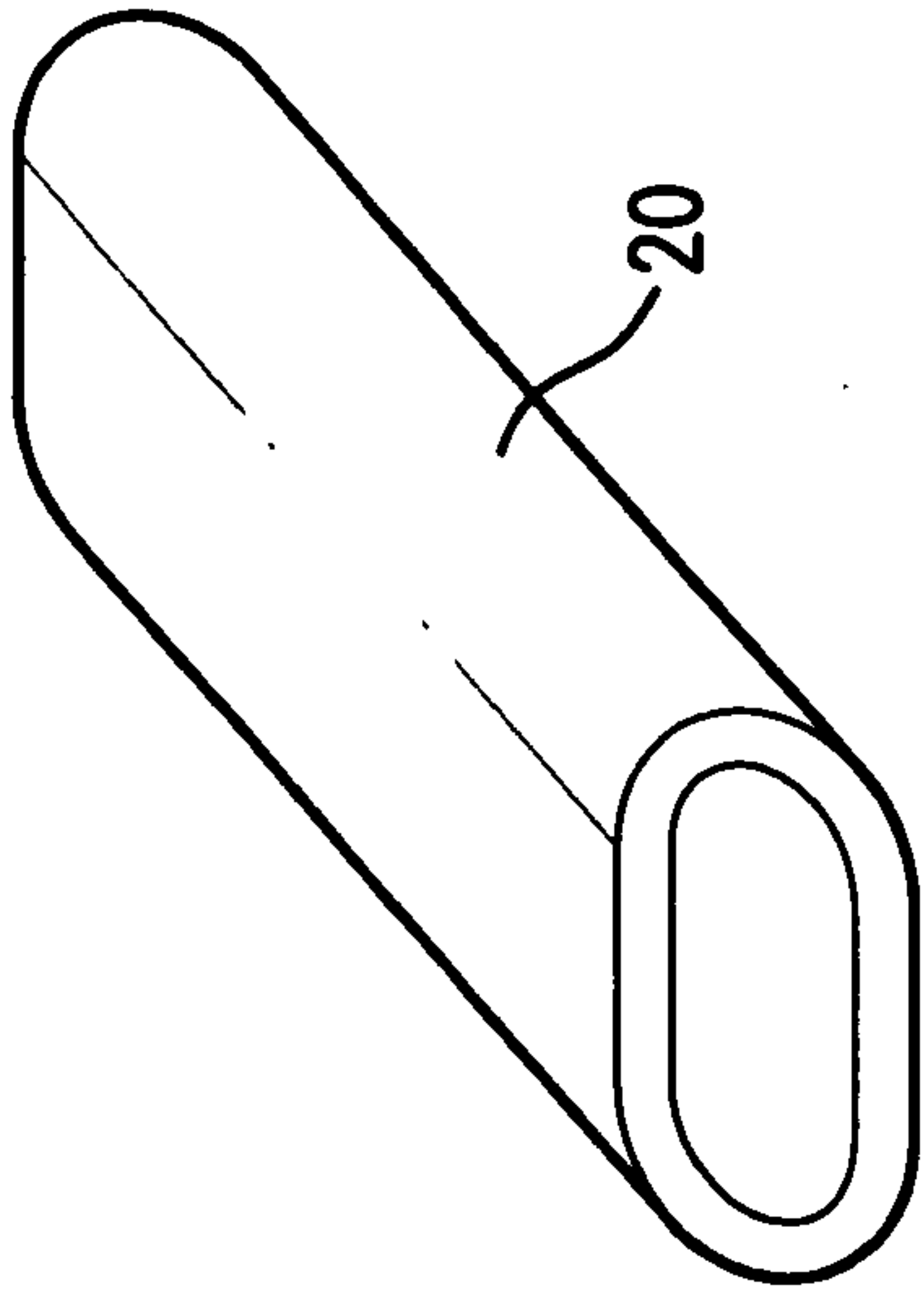


FIG. 5B

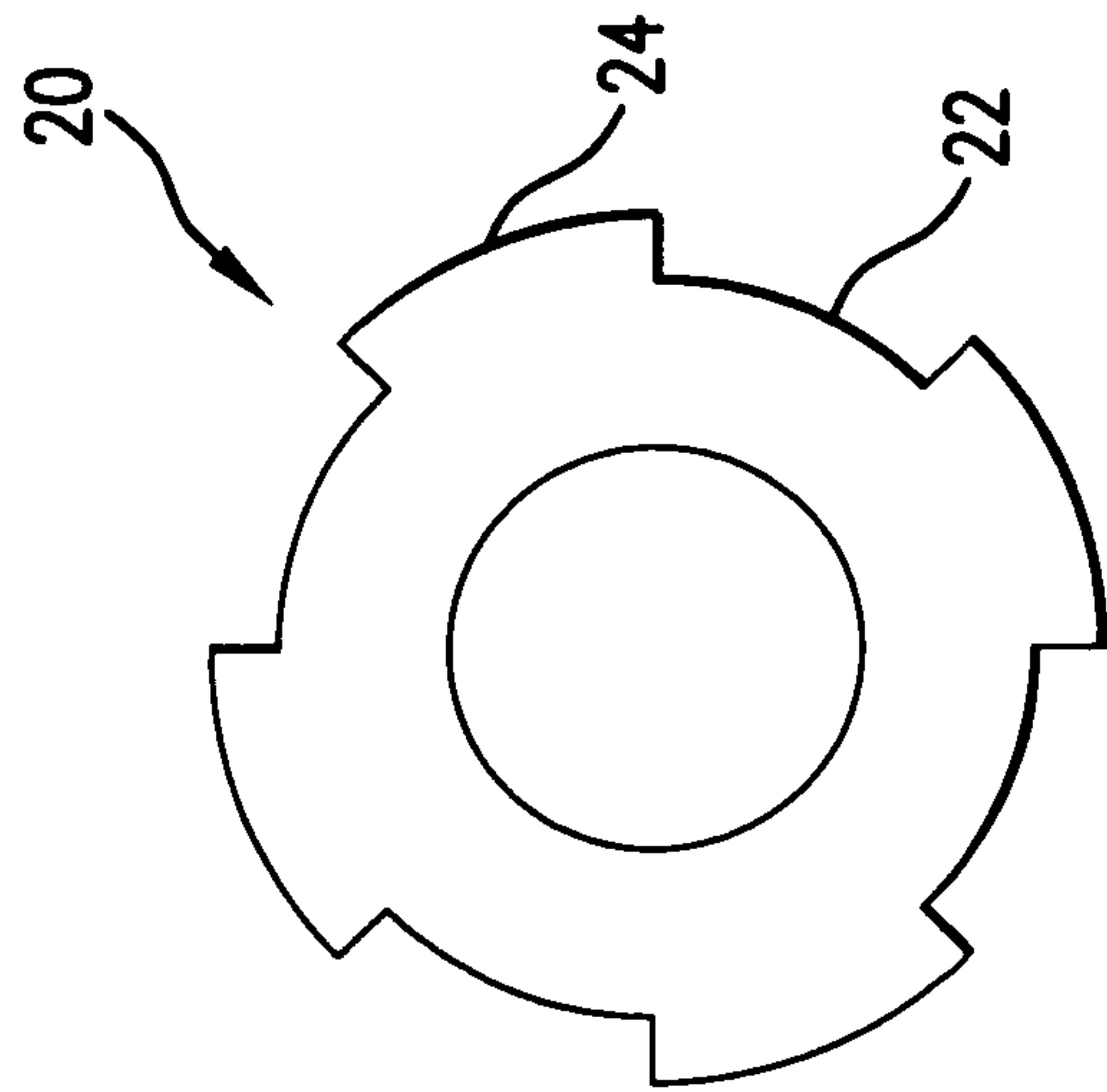


FIG. 5C

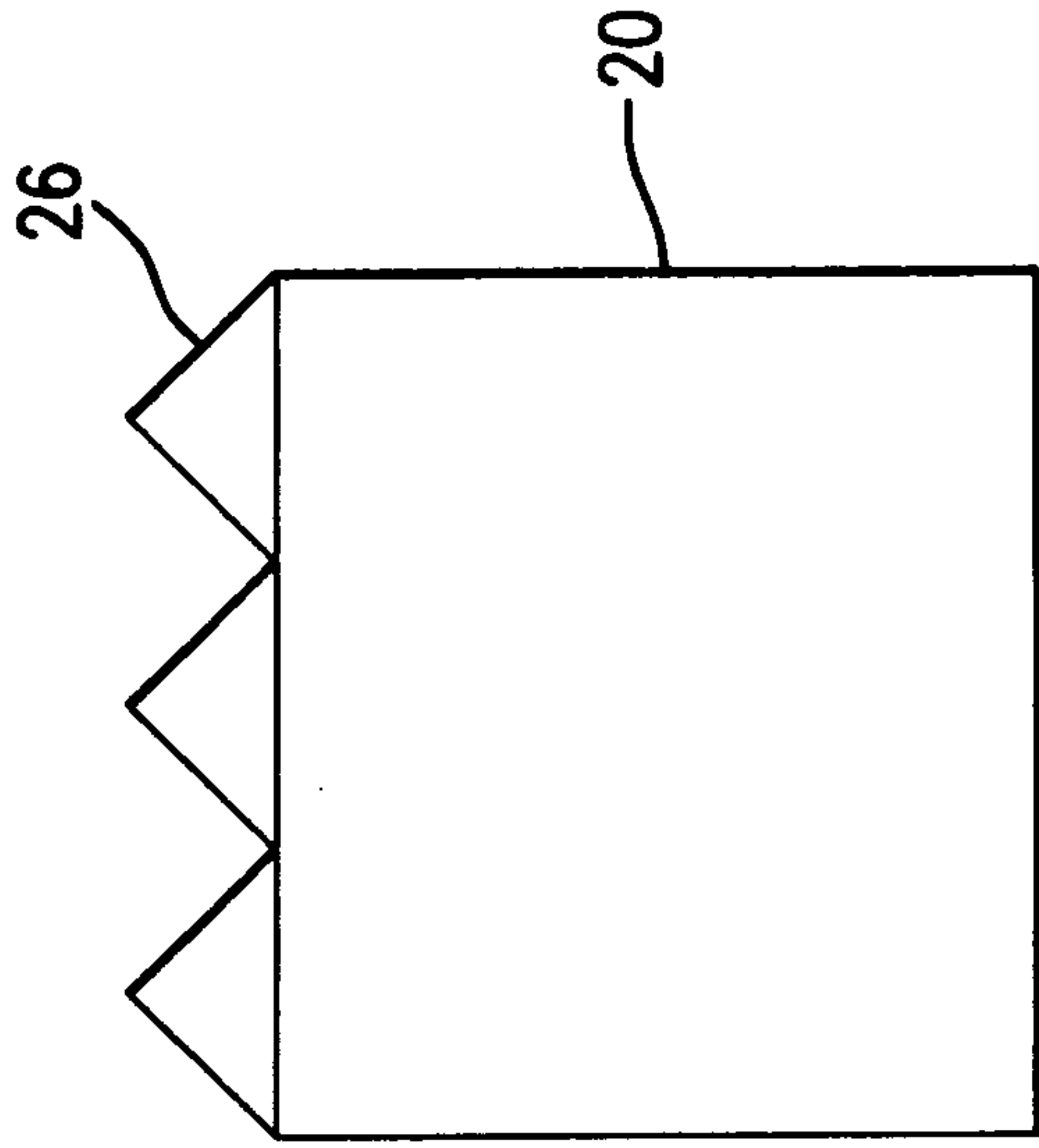


FIG. 5D

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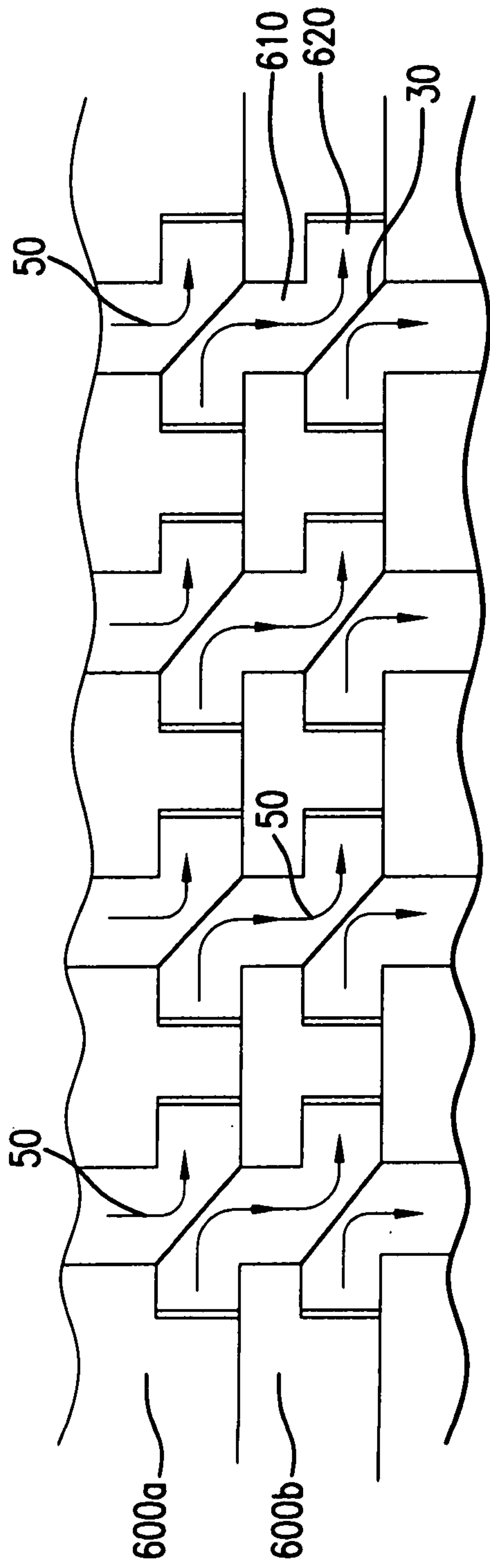


FIG. 6A

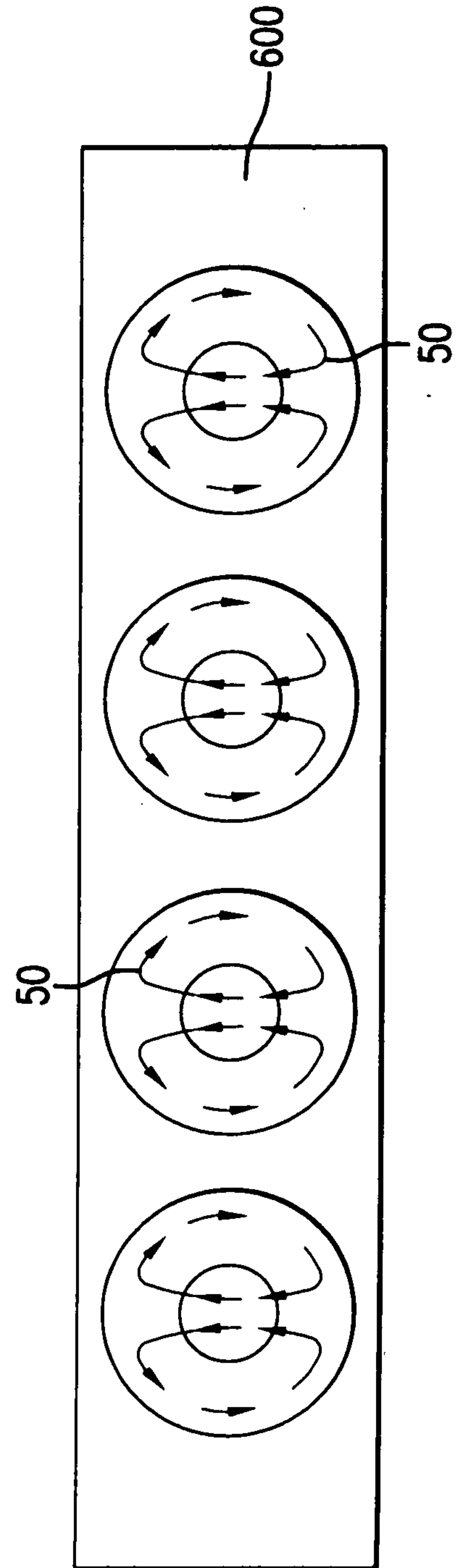


FIG. 6B

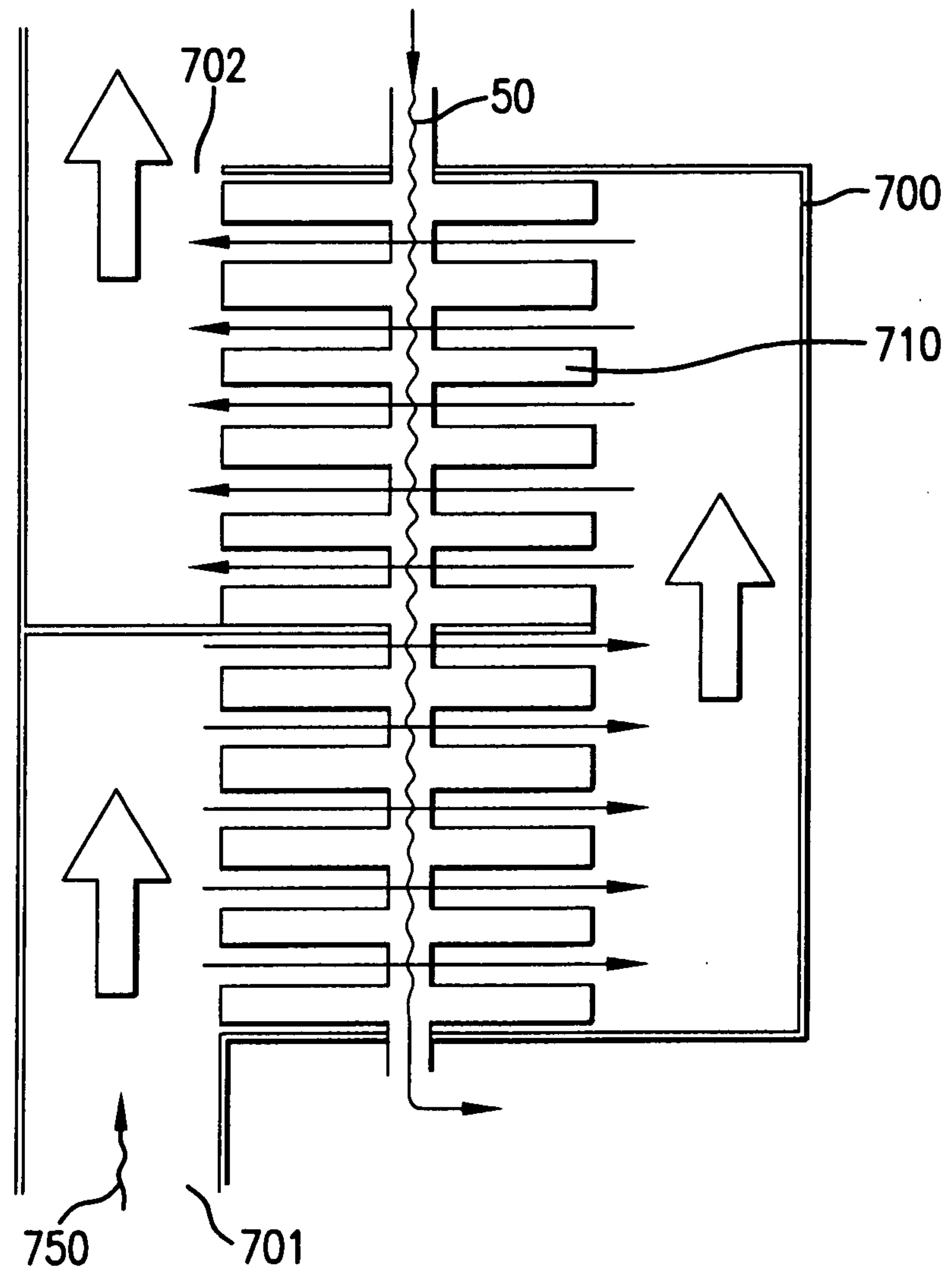


FIG. 7

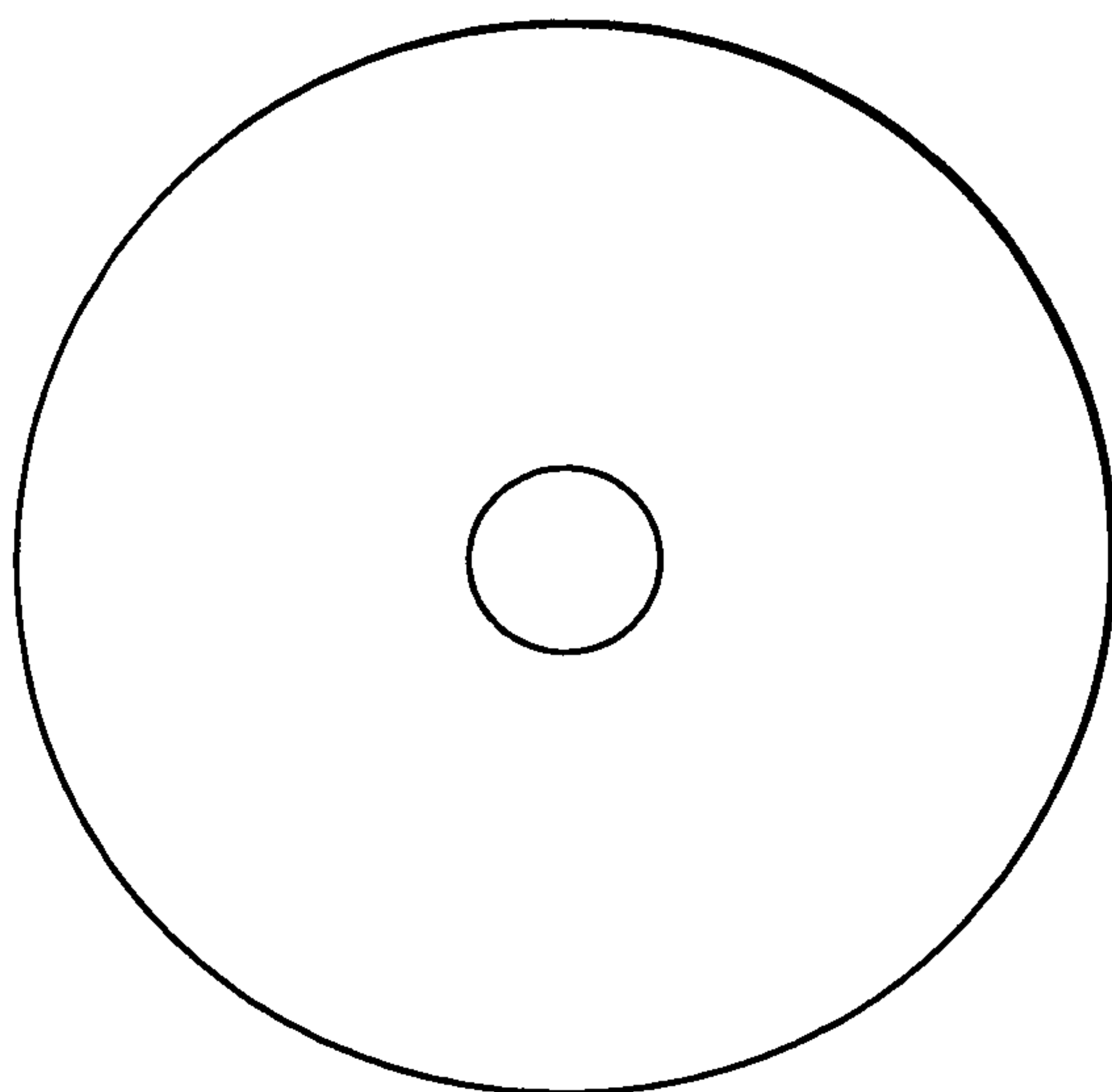


FIG. 8B

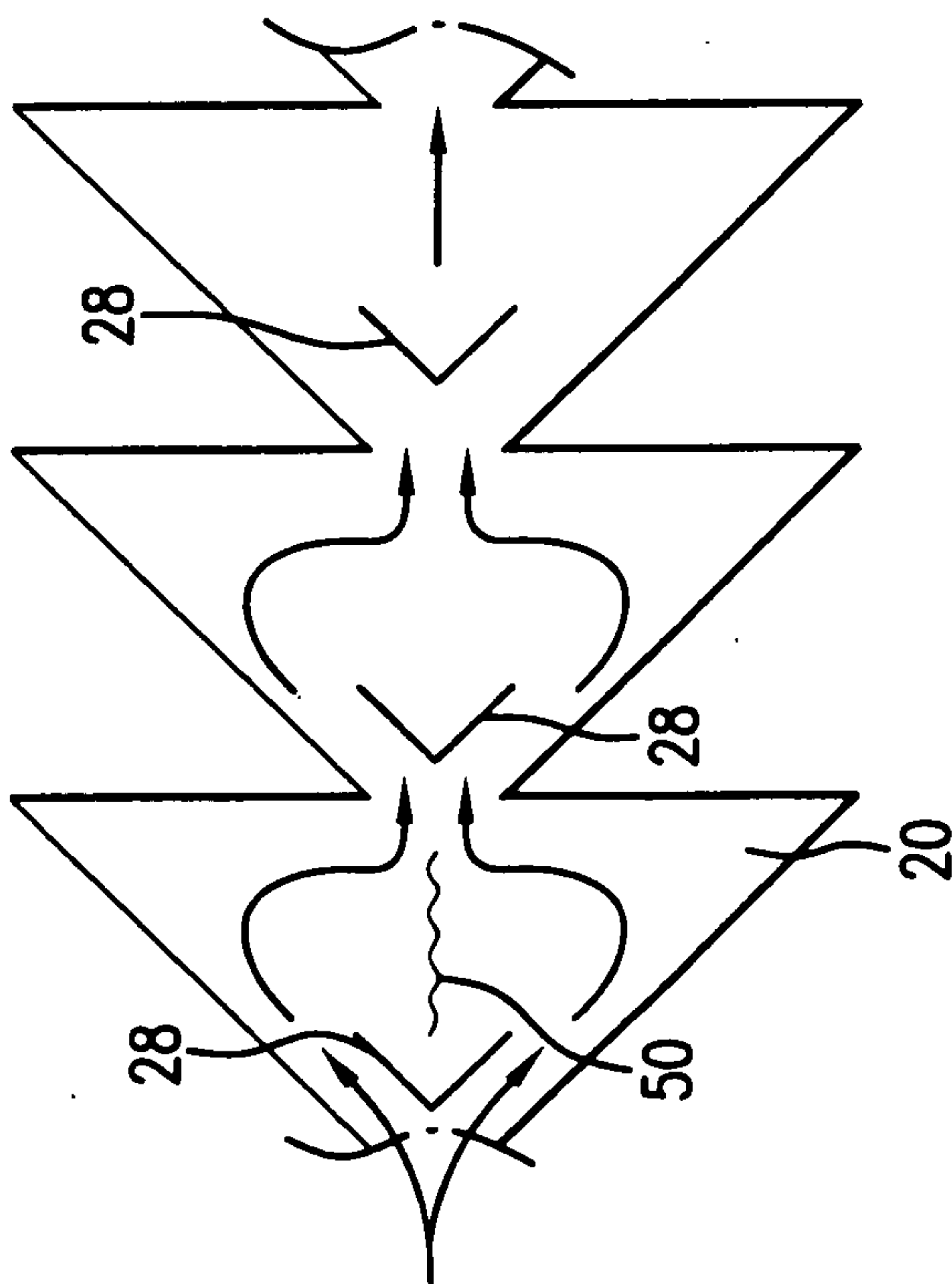


FIG. 8A

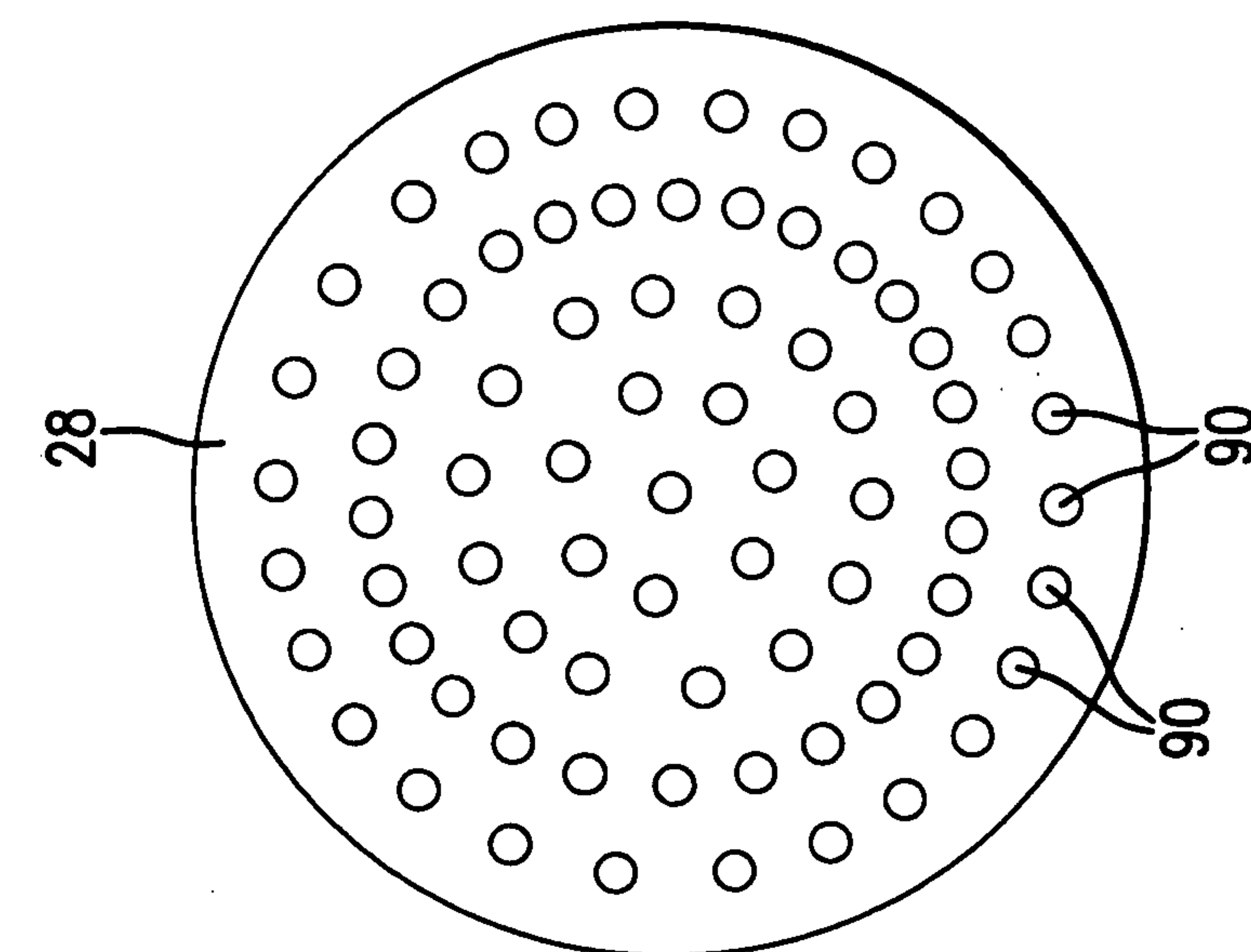


FIG. 9B

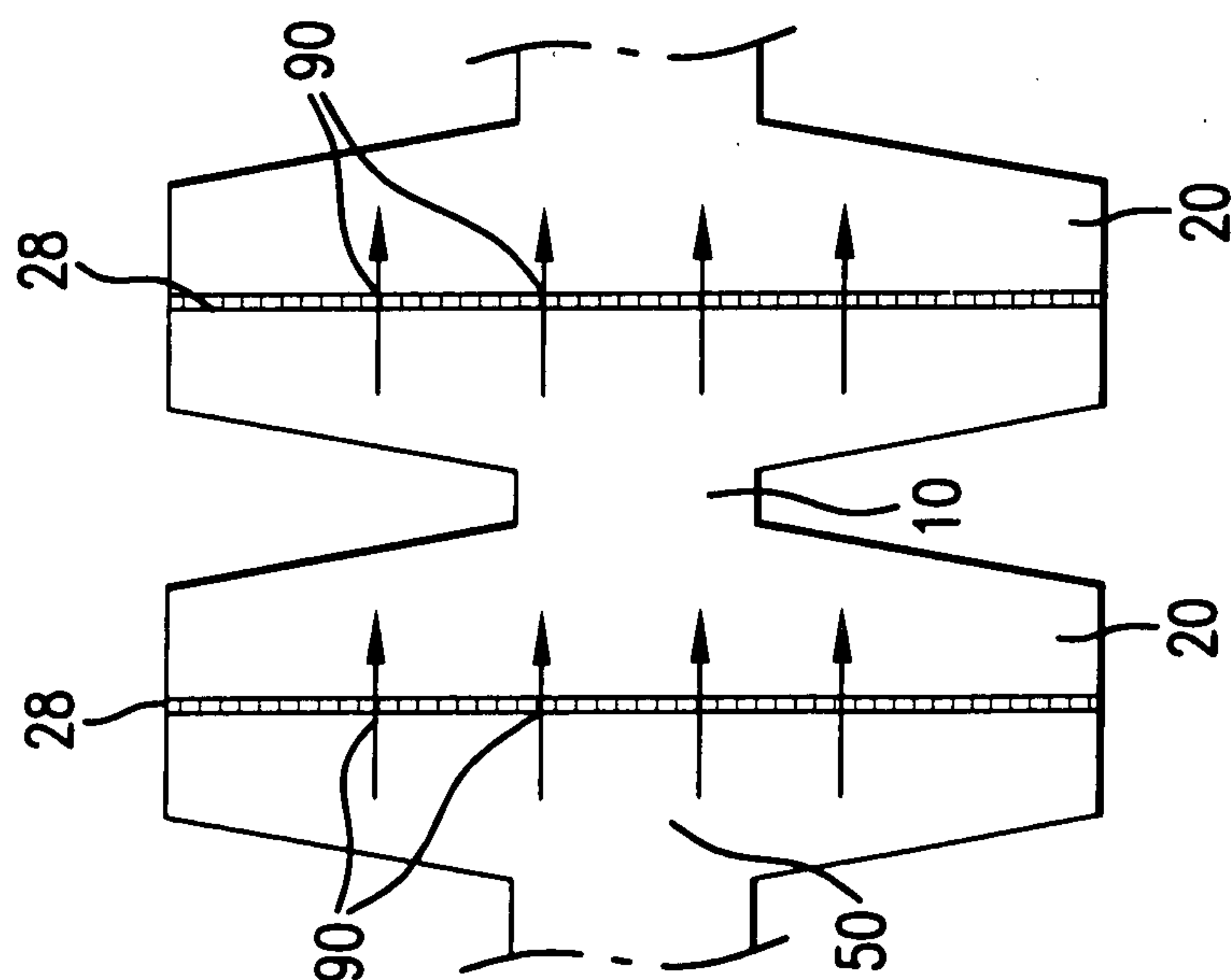


FIG. 9A

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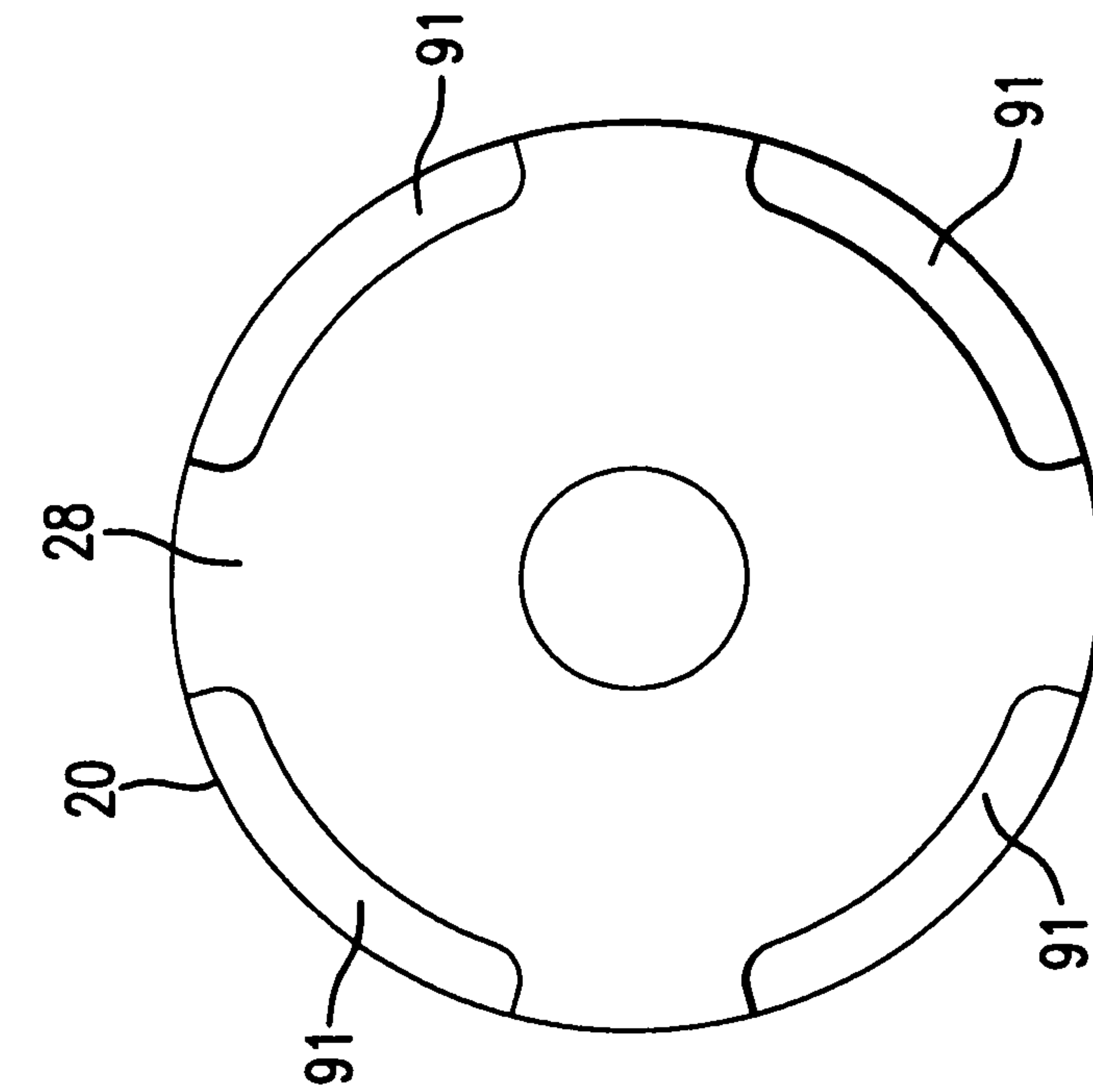


FIG. 10B

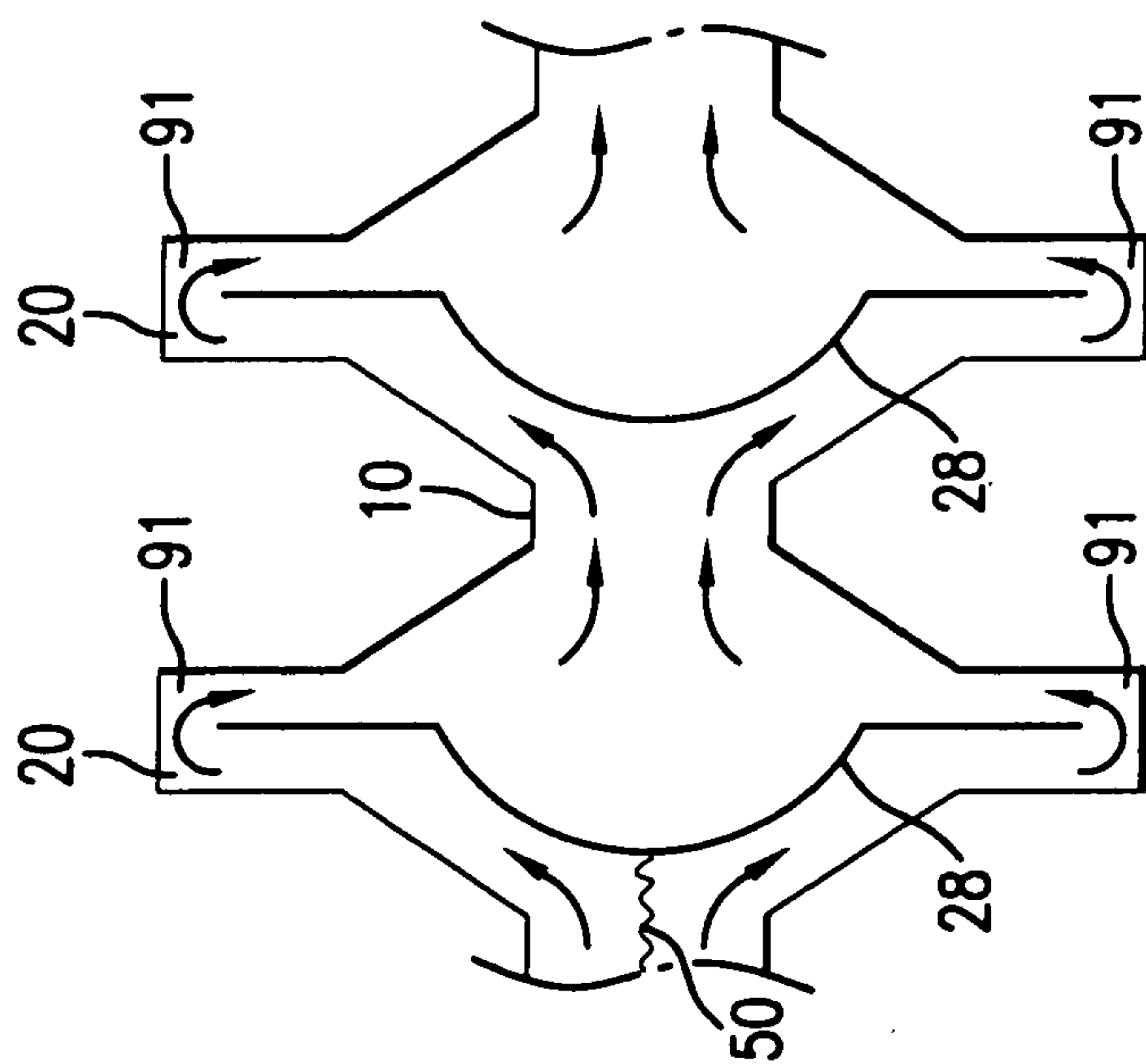


FIG. 10A

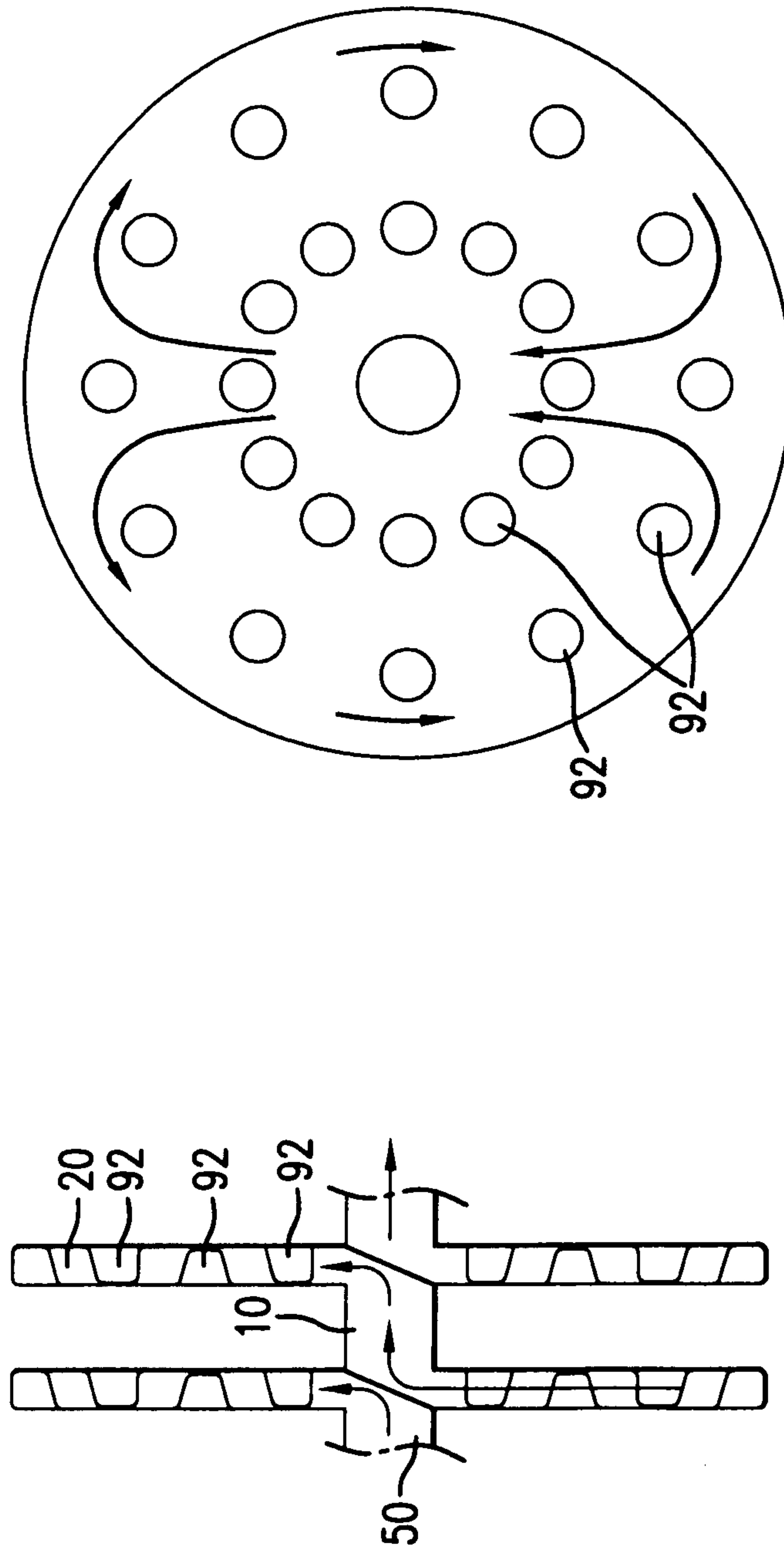


FIG. 11B

FIG. 11A

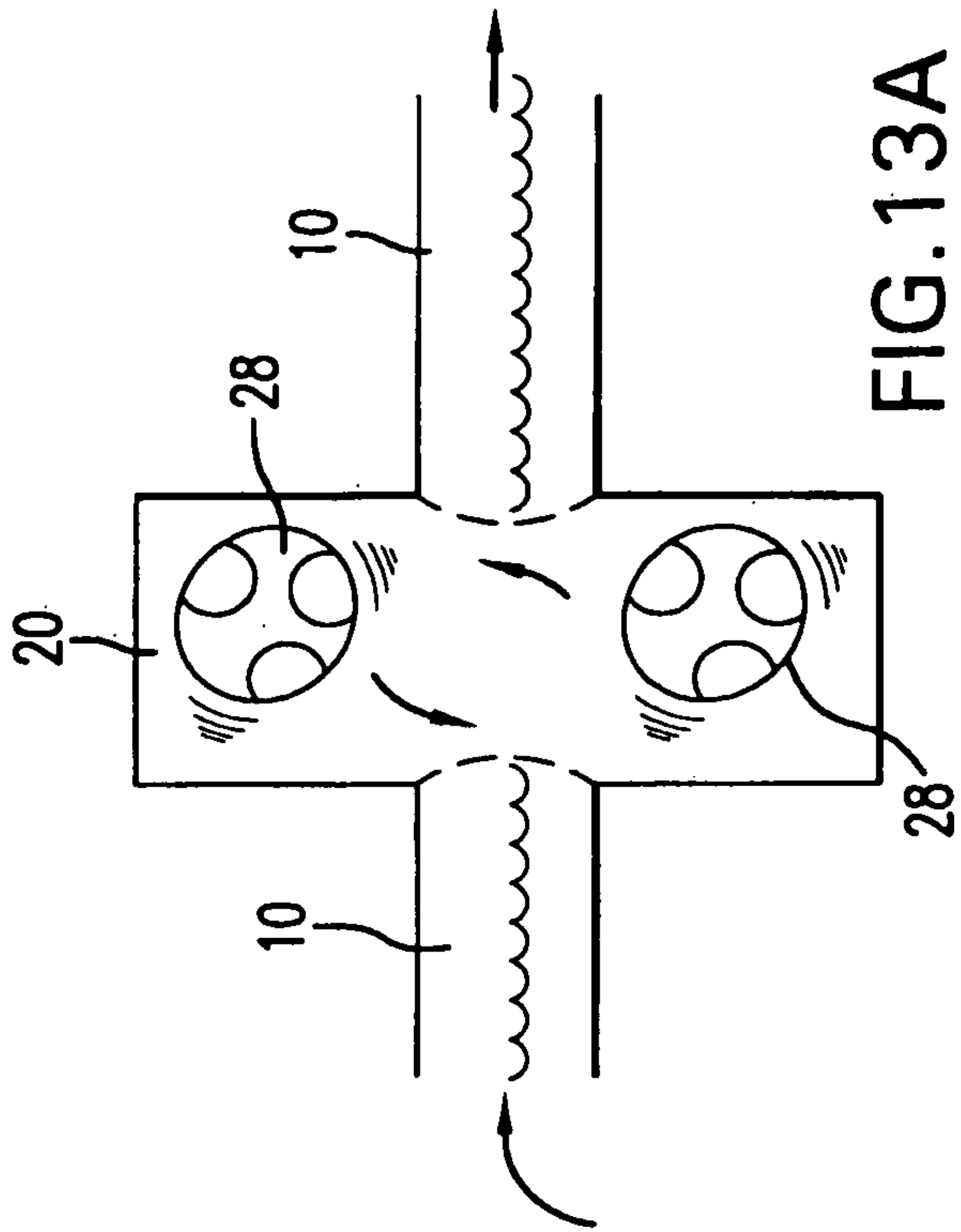


FIG. 13A

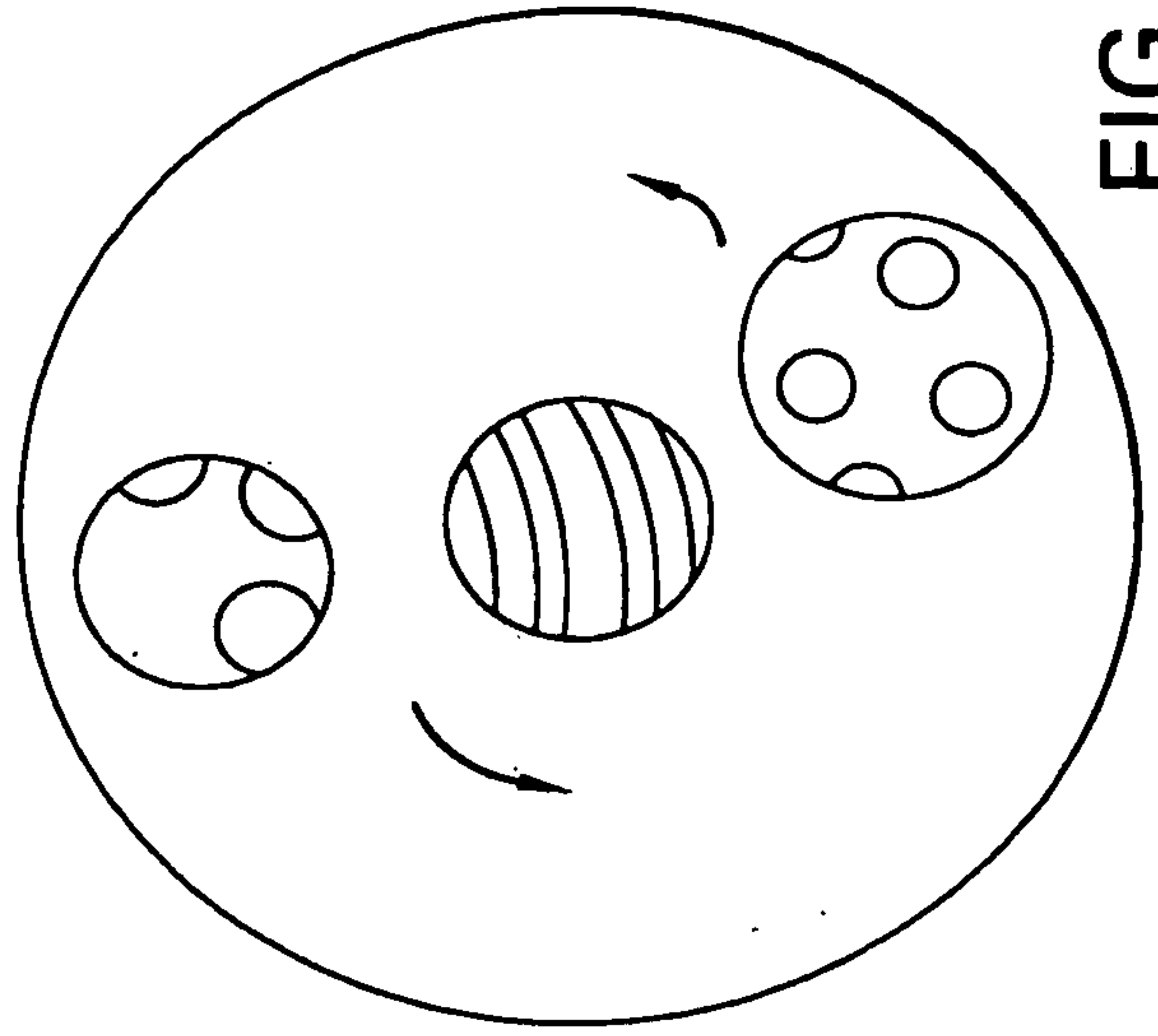


FIG. 13B

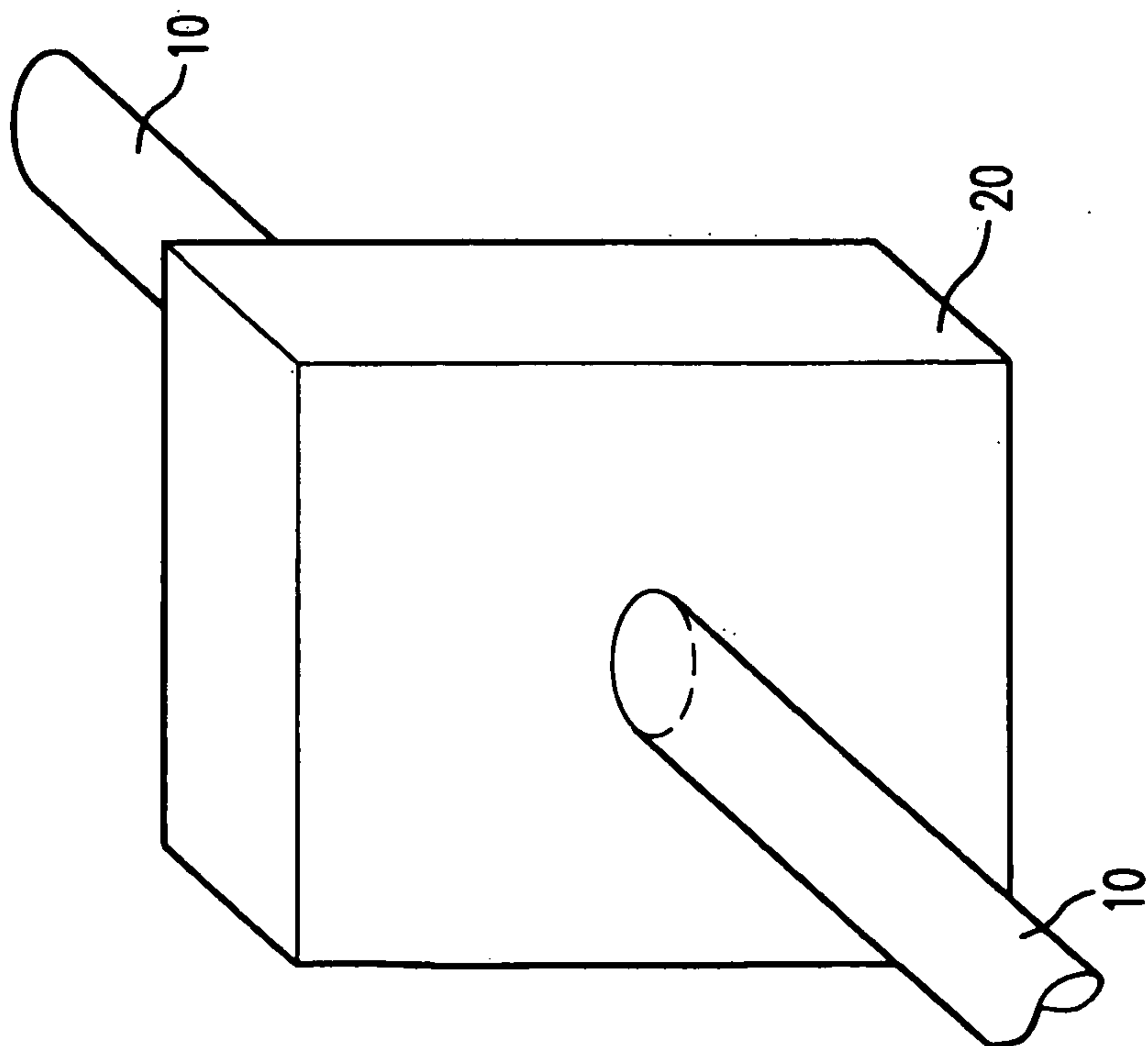


FIG. 12

