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(54) **Topper and bed with targeted fluid flow distribution and preferential fluid flow distribution**

(57) A topper (38) for a bed extends in longitudinal and lateral directions and includes a fluid flowpath (60) for channeling fluid through the topper from an inlet (62) to an outlet (64). The flowpath is configured to distribute the fluid to a preferred target region (50) of the topper. A bed which includes the topper has a blower (72) connected to the topper inlet for supplying air (88) to the flowpath.

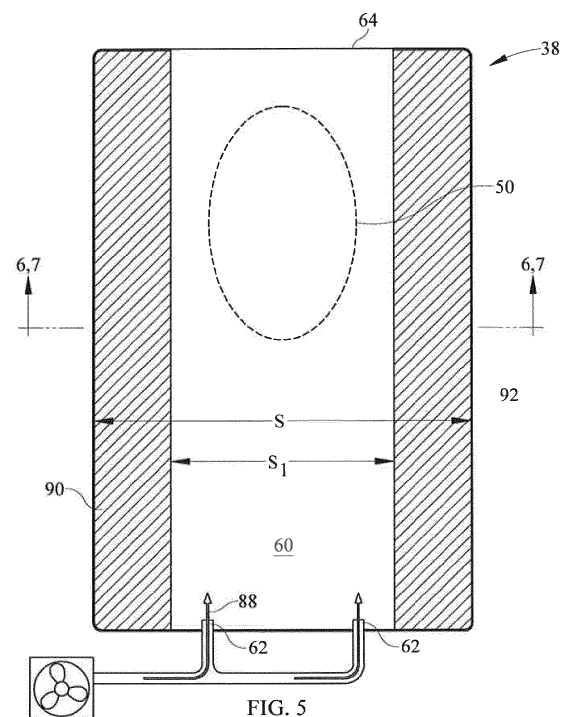


FIG. 5

Description

Technical Field

[0001] The subject matter described herein relates to mattress toppers of the kind used in connection with beds, in particular a microclimate control topper having features for preferentially distributing fluid flowing through the topper to locations where fluid flow is expected to be of most benefit to an occupant of the bed.

Background

[0002] Microclimate control toppers are typically used in conjunction with the mattresses of beds found in hospitals, nursing homes, other health care facilities, or in home care settings. The topper rests atop the mattress and is secured thereto by, for example, straps, snaps or zippers, or may be more permanently integrated into the mattress, for example by stitching or welds appropriate to the materials from which the mattress and topper are made. A fluid flowpath having an inlet and an outlet extends through the interior of the topper. A pump or similar device supplies a stream of air to the topper so that the air flows into the flowpath by way of the inlet, flows through the flowpath, and exhausts from the flowpath by way of the outlet. The airstream establishes a microclimate in the vicinity of the occupant's skin. Specifically, the airstream helps cool the occupant's skin thereby reducing its nutrient requirements at a time when it is compressed by the occupant's weight and therefore likely to be poorly perfused. The airstream also helps reduce humidity in the vicinity of the occupant's skin thus combating the tendency of the skin to become moist and soft and therefore susceptible to breakdown.

[0003] The need for microclimate control is not uniformly distributed over the occupant's skin. For example skin temperature on the occupant's torso can be considerably higher than skin temperature on the occupant's arms and legs. In addition, nonuniform distribution of sweat glands causes perspiration to accumulate on the skin of the occupant's back and pelvic region. Moreover, many modern beds are profile adjustable. When the bed profile is adjusted the occupant's tissue is exposed to shear which distorts the vasculature and further degrades perfusion.

Summary

[0004] The present application discloses a topper for a bed. The topper extends in longitudinal and lateral directions and includes a fluid flowpath for channeling fluid through the topper from an inlet to an outlet. The flowpath is configured to distribute the fluid to a preferred target region of the topper. The application also discloses a bed which includes the topper and a blower connected to the topper inlet for supplying air to the flowpath.

[0005] The subject matter described herein also in-

cludes a bed comprising a mattress and a topper resting atop the mattress and extending in longitudinal and lateral directions. The topper has a fluid flowpath having an inlet and an outlet. The flowpath exhibits a nonuniform resistance to fluid flow in at least one of the longitudinal and lateral directions. The bed also includes a blower connected to the inlet for supplying air to the flowpath. The resistance may be a monotonically varying resistance to fluid flow in at least one of the longitudinal and lateral directions and configured to preferentially drive fluid flow through the topper so that a larger proportion of the fluid flowing through the topper flows under a target region and a relatively smaller portion bypasses the target region. The subject matter described herein also includes a topper for a bed, the topper extending in longitudinal and lateral directions and including a fluid flowpath having an inlet and an outlet. The flowpath exhibits a nonuniform resistance to fluid flow in at least one of the longitudinal and lateral directions.

[0006] Any feature in one embodiment of the invention may be applied to other embodiments of the invention. In particular, bed aspects may be applied to topper aspects, and vice versa. Furthermore, any, some and/or all features in one embodiment or aspect can be applied to any, some and/or all features in any other embodiment or aspect in any appropriate combination.

[0007] Although the invention is described below in connection with specific preferred embodiments, it should be understood that the invention should not be unduly limited to such specific embodiments, and that a feature or features of one described embodiment may be equally applicable to one or more other embodiments described herein.

Brief Description of the Drawings

[0008] Embodiments of the invention in its various aspects will now be described by way of non-limiting example with reference to the accompanying drawings in which:

FIGS. 1-4 are simplified perspective, plan, side elevation and end elevation views of a mattress and a conventional topper having a fluid flowpath extending therethrough.

FIG. 5 is a plan view of a topper having linear margins and a laterally symmetric fluid flowpath for distributing fluid flowing through the flowpath to a preferred target region of the topper.

FIG. 6 is a cross section taken along section line 6--6 of FIG. 5 showing a first alternative construction of the topper.

FIGS. 7A and 7B are cross sections taken along section line 7--7 of FIG. 5 showing a second alternative construction of the topper.

FIG. 8 is a plan view of a topper having contoured margins and a laterally symmetric fluid flowpath for distributing fluid flowing through the flowpath to a preferred target region of the topper and also showing a pattern of fluid flow through the topper.

FIGS. 9-10 are cross sections taken along section lines 9--9 and 10--10 of FIG. 8 showing a first alternative construction of the topper.

FIGS. 11-12 are cross sections taken along section lines 11--11 and 12-12 of FIG. 8 showing a second alternative construction of the topper.

FIGS. 13-15 are plan views similar to that of FIG. 8 showing other variants of contoured margins and laterally symmetric fluid flowpaths.

FIG. 16 is a plan view similar to that of FIG. 8 showing another variant of a topper with contoured margins but with a laterally asymmetric fluid flowpath.

FIGS. 17-19 are plan views similar to that of FIG. 8 each showing a longitudinally foreshortened flowpath.

FIG. 20 is a plan view showing a topper with longitudinally extending, coflowing fluid flow passages, an array of sensors capable of sensing a parameter useable for determining weight distribution of a person whose weight bears on the topper, a blower and a controller.

FIG. 21 is a view in the direction 21--21 of FIG. 20.

FIGS. 22-25 are plan views similar to that of FIG. 21 showing laterally extending coflowing passages (FIGS. 22, 24) and counterflowing passages (FIGS. 23, 25).

FIGS. 26-27 are a plan view and a cross sectional view of a topper having coflowing nested keyhole passages whose inlets and outlets are at the foot end of the topper.

FIG. 28 is a plan view similar to that of FIG. 26 showing counterflowing keyhole passages.

FIG. 29 is a plan view similar to that of FIG. 26 showing coflowing keyhole passages whose inlets and outlets are at the right edge of the topper.

FIG. 30 is a plan view similar to that of FIG. 29 showing counterflowing, laterally extending passages with a central bulge so that the passages, taken collectively, define a two-sided keyhole configuration.

FIGS. 31-34 are end elevation views of variants of

a topper for use in an arrangement similar to that shown in FIGS. 1 to 4 and as described herein, each exhibiting a spatially nonuniform resistance to fluid flow through the topper as a result of a spatially nonuniform distribution of the properties of a filler material.

FIG. 35 is a plan view showing a fluid flow pattern representative of the fluid flow pattern attributable to the spatially varying resistance characteristics of the toppers of FIGS. 31-34.

FIGS. 36A and 36B are plan views of a variant of a topper as described herein exhibiting a spatially nonuniform fluid flow resistance as the result of pores or tubules in a filler material which are locally oriented to encourage an airstream to flow in a desired direction and impede it from flowing in other directions.

FIG. 37 is a plan view similar to that of FIG. 35 showing a fluid flow pattern attributable to longitudinally nonuniform fluid flow resistance rather than the laterally nonuniform resistance of FIGS. 31-34.

FIGS. 38-40 are views similar to those of FIG. 32 in which partitions divide the flowpath into channels.

FIG. 41 is a plan view showing a fluid flow pattern representative of the fluid flow pattern attributable to the spatially varying resistance characteristics of the toppers of FIGS. 38-40.

FIGS. 42-43 are end elevation views showing an alternate topper construction comprising an insert and a cover or ticking.

Detailed Description

[0009] FIGS. 1-4 show a conventional topper 20 resting atop a mattress 24. The topper extends longitudinally from a head end 26 to a foot end 28 and spans laterally from a left side 32 to a right side 34. A longitudinally extending centerline 40 and centerplane 42 and a spanwise centerplane 44 are shown for reference. The topper has an upper or occupant side surface 46 and a lower or mattress side surface 48. A target region 50 on upper surface 46 is a region corresponding to a portion of an occupant's body judged to be especially needful of local climate control. The illustrated target region corresponds approximately to the torso of a representative patient lying face up (supine) and centered on the topper. A fluid flowpath 60 having an inlet 62 and an outlet 64 spans laterally across the topper from its left side 32 to its right side 34 and extends longitudinally through the topper. In the illustrated topper inlet 62 is a local inlet port at the foot end of the topper and outlet 64 is a wide vent opening at the head end of the topper. Other inlet and outlet designs may be used.

[0010] In the illustrated topper a filler material **70** occupies the flowpath but does not prohibit fluid, particularly air, from flowing through the topper from inlet **62** to outlet **64**. Alternatively, the filler material may be absent. A blower **72** or similar device is connected to the inlet by a hose **74** having a blower end **76** and a topper end **78** so that the blower can impel a stream **88** of air to flow through the flowpath. The illustrated topper has no provisions for preferentially directing airstream **88** or any portion thereof to the target region. In particular, the airstream can spread out laterally across the entire span **S** of the topper through the entire longitudinal length of the topper.

[0011] FIG. **5** shows an embodiment of an innovative topper **38** for a bed. As with the previously described topper the improved topper is configured to rest atop a mattress such as mattress **24** of FIGS. **1**, **3** and **4**. The topper extends in longitudinal and lateral directions and includes a fluid flowpath **60** for channeling a stream of air **88** through the topper from an inlet **62** to an outlet **64**. In the illustrated topper inlet **62** is a pair of inlet ports at the foot end of the topper and outlet **64** is a wide vent opening at the head end of the topper. Other inlet and outlet designs may be used. Unlike the topper of FIGS. **1-4**, the topper of FIG. **5** is configured to distribute air flowing through the flowpath to a preferred target region **50** of the topper, specifically a region **50** corresponding approximately to the torso of a supine person substantially laterally centered on the topper, although other target regions can be defined, if desired. In particular, the topper includes left and right margins **90**, **92** linearly bordering flowpath **60**. As a result airstream **88** cannot spread across the entire span **S** of the topper but instead is confined to span **S1** through the entire longitudinal length of the topper. As a result the airstream is more concentrated under the target region than is the case with the conventional topper of FIGS. **1-4**.

[0012] FIG. **6** is a cross section in the direction **6--6** of FIG. **5** showing a first alternative construction of the topper. The topper comprises a central region **96** corresponding to flowpath **60** and the margins **90**, **92** each joined to the central region at a seam **98**. Example margins include foam or an inflated static bladder, i.e. a bladder through which air does not flow. The nature of seam **98** depends on the materials used to make the central region and margins.

[0013] FIGS. **7A** and **7B** are cross sections in the direction **7--7** of FIG. **5** showing two variants of a second alternative construction of the topper. In the second alternative, central region **96**, which corresponds to flowpath **60**, and margins **90**, **92** comprise an insert **100** enclosed by a ticking **104** (FIG. **7A**) or covered by a ticking **104** (FIG. **7B**). The central region and margins are attached to each other at a seam **98** or other suitable connection.

[0014] FIG. **8** shows another topper configured to distribute air flowing through the flowpath to preferred target region **50** of the topper. In particular, the topper includes left and right arcuate margins **90**, **92** bordering flowpath

60. The margins converge toward each other with increasing distance from the head and foot ends **26**, **28** of the topper to define a throat **T** (coincident with section lines **9-9** and **11-11**). As a result of the flowpath shape arising from the curved borders, airstream **88** is more concentrated under the target region than is the case with the conventional topper of FIGS. **1-4**.

[0015] FIGS. **9** and **10** are cross sections taken along section lines **9--9** and **10--10** of FIG. **8** and correspond to the first alternative construction shown in FIG. **6**. FIGS. **11** and **12** are cross sections taken along section lines **11--11** and **12--12** of FIG. **8** and correspond to the second alternative construction shown in FIG. **7A**.

[0016] FIG. **13** shows an embodiment in which the margins diverge away from each other with increasing distance from the head and foot ends **26**, **28** of the topper. The resulting flowpath allows airstream to diffuse laterally as it moves from inlet **62** toward plane **106** of maximum flowpath cross section and then to accelerate as it flows from plane **106** to outlet **64**.

[0017] FIG. **14** shows an embodiment having a dual inlets **62** and dual intake conduits **110** for channeling airstream **88** to a working region **112** of the flowpath, and a single outlet **64** and a single discharge conduit **114** for exhausting the airstream from the working region. The working region corresponds approximately to the target region which may correspond to the torso of a supine person substantially laterally centered on the topper.

[0018] FIG. **15** shows an embodiment similar to that of FIG. **14** but having dual outlets **64** and a pair of discharge conduits **114** for channeling airstream **88** away from working region **112** of the flowpath. The working region corresponds approximately to the target region **50** which may correspond to the torso of a supine person substantially laterally centered on the topper.

[0019] FIG. **16** shows an embodiment having a single inlet **62** and a single intake conduit **110** for channeling airstream **88** to working region **112** and a single outlet **64** and a single discharge conduit **114** for exhausting the airstream from the working region. The working region corresponds approximately to the target region which may correspond to the torso of a supine person substantially laterally centered on the topper. Unlike the embodiments of FIGS. **5-15** in which the flowpath is symmetric with respect to centerplane **42**, the flowpath of FIG. **16** is asymmetric with respect to centerplane **42**.

[0020] FIG. **17** shows an embodiment similar to that of FIG. **8** but with dual inlets **62** and a longitudinally foreshortened flowpath **60**.

[0021] FIG. **18** shows an embodiment similar to that of FIG. **17** but with a working region **112** having an arched planform and a discharge conduit **114** extending obliquely from the target region.

[0022] FIG. **19** shows an embodiment similar to that of FIG. **18** but with a working region **112** having a rectangular planform.

[0023] FIGS. **20** and **21** show a topper in which flowpath **60** is divided into a set of five longitudinally extend-

ing, laterally distributed fluid passages **120**. The topper also includes an array of sensors **122** capable of sensing a parameter useable for determining weight distribution of a person whose weight bears on the topper. One example is an array of pressure sensors. A blower **72** is in fluid communication with topper flowpath **60** by way of a plumbing network featuring a main feed pipe **124** and a set of branch pipes **126** each outfitted with a valve **130** and each connected to the foot end of one passage. The passages are coflowing passages, i.e. airflow in all the passages is in the same direction -- from the foot end toward the head end. A controller **132** is in communication with the sensors, the valves and the blowers as indicated by communication pathways **134**, **136** and **138**. Although communication pathways **134**, **136**, **138** suggest a tangible physical connection, other avenues of communication, such as wireless communication, can also be employed. In operation the controller receives a signal or signals representing a value or values of the sensed parameter or parameters and controls the valves to cause air to be metered to the passages **120** in response to the signal or signals such that a larger proportion of fluid supplied to the flowpath is directed to the target region and a smaller proportion bypasses the target region. For example in the illustrated topper, rather than distributing air from blower **72** equally among the passages, the controller could be programmed to meter only 10% of the air to each of passages **120A**, **120E** and to distribute the remaining 80% equally or unequally among channels **120B**, **120C**, **120D**. Other distributions could be commanded depending on changes in the location of the target region which result from changes in the position of the occupant as detected by the sensors.

[0024] The controller of FIG. **20** is an on-board controller in that it is mounted on the bed itself. Alternatively the controller could be an off-board controller. Off-board controllers include controllers that are components of facility communication and data processing networks.

[0025] The foregoing describes topper embodiments in which the flowpath extends predominantly longitudinally through the topper. Alternatively (e.g. FIG. **22**) the flowpath can extend predominantly laterally through the topper.

[0026] FIG. **22** shows a topper similar to that of FIGS. **20-21** except with laterally extending, longitudinally distributed fluid passages **120**. In general the passages are distributed across one of the directions (laterally as in FIG. **20** or longitudinally as in FIG. **22**) and extend in the other of the directions (longitudinally as in FIG. **20** or laterally as in FIG. **22**).

[0027] FIGS. **20** and **22** illustrate the use of sensors **122** so that the topper, with the assistance of controller **132** and valves **130**, can adapt to changes in the position of the patient. Alternatively, the sensors can be dispensed with, and airflow can be distributed nonuniformly among the passages with appropriately designed, non-adjustable flow restrictions governing airflow through each branch pipe (e.g. as seen in FIG. **23** where the

branch pipes feeding passages **120C**, **120D** and **120E** each terminate with a relatively large diameter flow restrictor and the branch pipes feeding the other passages each terminate with a relatively small diameter flow restrictor). However such an arrangement would not be able to automatically adapt to changes in occupant position. In another alternative the flow restrictions may be manually adjustable rather than automatically adjustable. Such an arrangement might be useful to adapt the distribution of airflow to occupant specific target regions, e.g. a smaller target region for a patient of smaller size and a larger target region for a patient of larger size.

[0028] FIG. **23** shows a topper similar to that of FIG. **22** but with counterflowing passages, i.e. air flows right to left in passages **120B**, **120D**, **120F** and left to right in the other passages. FIG. **23** also illustrates the use of appropriate flow restriction to regulate airflow distribution among the passages.

[0029] FIG. **24** shows a topper similar to that of FIG. **23** but with a flowpath that increases in longitudinal dimension with increasing lateral distance from the inlets and outlets. The passages are coflowing passages. The illustrated topper does not use sensors, valves or flow restrictions to govern the distribution of airflow through the passages, however such use is within the scope of this disclosure.

[0030] FIG. **25** shows a counterflowing variant of the topper of FIG. **24**.

[0031] FIGS. **26-27** show a topper in which a principal topper flowpath **60P** has a keyhole shape as seen in a plan view. The principle flowpath has three nested, coflowing fluid passages **120B**, **120C**, **120D**. The illustrated topper also has a secondary flowpath **60S** comprising passage **120A** outboard of the primary flowpath. A non-flowing region could be used in lieu of the secondary flowpath.

[0032] FIG. **28** shows a counterflowing variant of the topper of FIGS. **26-27**.

[0033] FIG. **29** shows a topper embodiment having a coflowing, keyhole shaped principal flowpath **60P** with nested passages **120** whose inlets **62** and outlets **64** are at the side of the bed rather than at a longitudinal end of the bed. The region outside the flowpath is a nonflowing region.

[0034] FIG. **30** shows a topper similar to that of FIG. **29** but with counterflowing, laterally extending passages having a bulging working region **112** so that the passages, taken collectively, define a two-sided keyhole configuration.

[0035] FIG. **31** shows a topper **538** whose flowpath exhibits a purposefully nonuniform resistance to fluid flow, specifically to airflow, in the lateral direction. The nonuniformity arises from a filler material **70** which air-stream **88** can flow through from inlet **66** to outlet **64** but whose height **H** varies laterally. Height **H** is relatively large at centerplane **42**, diminishes with increasing distance from the centerplane and then increases with further increase in distance from the centerplane. Resist-

ance to fluid flow and height **H** are related monotonically, i.e. as height increases, flow resistance decreases and vice versa. Accordingly, although the dominant direction of fluid flow is the longitudinal direction, a greater proportion of airstream **88** flows under the target region than is the case in the conventional topper of FIGS. 1-4. This is evident by comparing the flow pattern of FIG. 35 to that of FIG. 2.

[0036] FIG. 32 shows another topper whose flowpath exhibits a purposefully nonuniform airflow resistance in the lateral direction. The nonuniformity arises from a filler material **70** such as a mesh or batting which airstream **88** can flow through from inlet **62** to outlet **64** but whose density varies laterally as signified by the density of the horizontal dashes used to represent the material. The material density is relatively low at centerplane **42** and increases with increasing distance from the centerplane. Resistance to fluid flow and density are related monotonically, i.e. as density increases, flow resistance decreases and vice versa. Accordingly, although the dominant direction of fluid flow is the longitudinal direction, a greater proportion of airstream **88** flows under the target region than is the case in the conventional topper of FIGS. 1-4. This is evident by comparing the flow pattern of FIG. 35 to that of FIG. 2.

[0037] FIG. 33 shows another topper whose flowpath exhibits a purposefully nonuniform airflow resistance in the lateral direction. The nonuniformity arises from a porous filler material **70** which airstream **88** can flow through from inlet **62** to outlet **64** but whose pore density (pore count per unit area) varies laterally. The pore density is relatively high near centerplane **42**, and diminishes with increasing distance from the centerplane. Resistance to fluid flow is related monotonically to pore density, i.e. as pore density decreases, flow resistance increases and vice versa. Accordingly, although the dominant direction of fluid flow is the longitudinal direction, a greater proportion of airstream **88** flows under the target region than is the case in the conventional topper of FIGS. 1-4. This is evident by comparing the flow pattern of FIG. 35 to that of FIG. 2.

[0038] FIG. 34 shows another topper whose flowpath exhibits a purposefully nonuniform airflow resistance in the lateral direction. The nonuniformity arises from a porous filler material **70** which airstream **88** can flow through from inlet **62** to outlet **64**, whose pore density is constant in the lateral direction, but whose pore size varies laterally. Pore size is relatively large near centerplane **42**, and diminishes with increasing distance from the centerplane. Resistance to fluid flow is related monotonically to pore size, i.e. as pore size decreases, flow resistance increases and vice versa. Accordingly, although the dominant direction of fluid flow is the longitudinal direction, a greater proportion of airstream **88** flows under the target region than is the case in the conventional topper of FIGS. 1-4. This is evident by comparing the flow pattern of FIG. 35 to that of FIG. 2.

[0039] FIG. 36A shows another topper whose flowpath

exhibits a purposefully nonuniform airflow resistance in the lateral direction. The nonuniformity arises from a filler material **70** having flow directing features such as tubules **586** (illustrated) fibers or high aspect ratio (high length/diameter ratio) pores having a length sufficient to influence the direction of fluid flow and which are oriented to encourage the airstream to flow in a desired direction and impede it from flowing in other directions.

[0040] Combinations of varying height, material density, pore density, pore size, pore or tubule or fiber orientation and other properties affecting resistance to fluid flow can be used to achieve the above described spatial variation in airflow resistance.

[0041] In the foregoing examples of FIGS. 31 to 36 the dominant direction of airflow is the longitudinal direction, although it will be appreciated that because of the laterally varying resistance to airflow (i.e. resistance variation perpendicular to the the dominant direction of fluid flow) the fluid streamlines also have a lateral directional component to preferentially drive a relatively larger proportion of the airstream to flow under the target region and a relatively smaller portion to bypass the target region. Alternatively, as seen in FIG. 37, the dominant direction of airflow can be the lateral direction with the fluid streamlines having a more modest longitudinal directional component for preferentially driving a relatively larger proportion of the airstream to flow under the target region and a relatively smaller portion to bypass the target region. In general the resistance varies spatially in a direction substantially perpendicular to a dominant fluid flow direction through the flowpath.

[0042] Because the target region is a region corresponding to the torso of an occupant approximately laterally centered on the topper, the flowpaths of the toppers of FIGS. 31 to 37 exhibit a resistance gradient across the target region such that airflow resistance is lower at relatively more inboard locations and higher at relatively more outboard locations. That is, resistance is relatively lower near centerplane **42** or **44** and increases with proximity to the sides **32**, **34** or the head and foot ends **26**, **28**.

[0043] FIGS. 38-40 and 41 illustrate toppers similar to those of FIGS. 32-34 but with longitudinally extending, laterally distributed partitions **592** joined to upper and lower topper surfaces **46**, **48**. The partitions divide flowpath **60** into longitudinally extending, laterally distributed parallel flow passages each occupied by a filler material. The four dividers in each illustration divide the flowpath into an inboard passage **594**, a pair of intermediate passages **596** flanking the inboard passage, and a pair of outboard passages **598** each laterally between an intermediate passage and either the left or right side of the topper. The filler material is selected to impart a relatively low fluid flow resistance to the inboard passage, an intermediate fluid flow resistance to the intermediate passages and a relatively high fluid flow resistance to the outboard passages. These flow resistances are achieved with low, medium and high material density (FIG. 38) high, medium and low pore density (FIG. 39) and large,

medium and small pore size (FIG. 40). Thus, airflow resistance differs from passage to passage but in a given passage is constant in the direction in which the passages are distributed, i.e. in the lateral direction. Alternatively a laterally nonuniform flow resistance can be established across each passage if desired. In addition although the illustrated passages are co-flowing passages (fluid flows from the foot end toward the head end in all passages) counter flowing passages can be employed. For example passages 594 and 598 could receive from inlets at their respective foot ends while passages 596 could receive air from an inlet at their head ends. In all cases each passage would have an outlet at its opposite end for exhausting the air.

[0044] As already noted in connection with the nonpartitioned embodiments of FIGS. 31-36 the dominant direction of fluid flow can be lateral rather than longitudinal. Similarly, the partitions of the partitioned embodiments of FIGS. 38-40 can be oriented so that they extend laterally and are distributed longitudinally with the result that the dominant direction of fluid flow is lateral rather than longitudinal. In general the passages extend in one direction (longitudinal or lateral) and are spatially distributed in the other direction (lateral or longitudinal) and the flow resistance differs from passage to passage but is constant in any given passage in the direction of passage distribution. Alternatively a nonuniform flow resistance can be established across each passage in the direction of passage distribution if desired.

[0045] FIGS. 42-43 shows a possible variation on the construction of the topper. The toppers of FIGS. 42-43 each comprise an insert 5110 which exhibits the nonuniform resistance and a cover or ticking 5112 that covers the insert. In FIG. 42 the ticking encloses the insert by circumscribing it. In FIG. 43 the ticking covers the insert but does not enclose it as in FIG. 42.

[0046] Although this disclosure refers to specific embodiments, it will be understood by those skilled in the art that various changes in form and detail may be made without departing from the subject matter set forth in the accompanying claims. It should also be appreciated that particular combinations of the various features described and defined in any of the described embodiments of the invention can be implemented and/or used independently.

[0047] Embodiments of the invention can be described with reference to the following numbered clauses, with preferred features laid out in the dependent clauses:

1. A topper for a bed, the topper extending in longitudinal and lateral directions and including a fluid flowpath for channeling fluid through the topper from an inlet to an outlet, the flowpath configured to distribute the fluid to a preferred target region of the topper.
2. The topper of clause 1 in which the flowpath is configured to distribute the fluid to a preferred target region of the topper as a result of being shaped to

distribute fluid to the target region.

3. The topper of any preceding clause in which the target region corresponds approximately to the torso of a supine person substantially laterally centered on the topper.

4. The topper of any preceding clause in which the flowpath extends predominantly laterally.

5. The topper of any of clauses 1 to 3 in which the flowpath extends predominantly longitudinally.

6. The topper of any preceding clause in which the fluid flowpath is an insert and wherein a ticking encloses the insert.

7. The topper of any of clauses 1 to 5 in which the fluid flowpath is an insert and wherein a ticking covers the insert.

8. The topper of any preceding clause in which the flowpath has a keyhole shape.

9. The topper of any preceding clause in which the flowpath includes fluid passages distributed across one of the directions and extending along the other of the directions.

10. The topper of clause 9 in which the passages are counterflow passages.

11. The topper of any preceding clause including sensors distributed on the topper, the sensors being capable of sensing a parameter useable for determining weight distribution of a person whose weight bears on the topper.

12. The topper of clause 11 including a controller which receives a signal representing a value of the sensed parameter and causes fluid to be metered to the passages in response to the signal such that a larger proportion of fluid supplied to the flowpath is directed to the target region and a smaller proportion bypasses the target region.

13. The topper of clause 11 in which signals representative of the sensed parameter are generated for use by an off-board controller capable of causing fluid to be metered to the passages in response to the signals such that a larger proportion of fluid flowing through the flowpath is directed to the target region and a smaller proportion bypasses the target region.

14. The topper of any preceding clause wherein the flowpath is configured to distribute the fluid to a preferred target region of the topper as a result of exhibiting a nonuniform resistance to fluid flow in at least one of the longitudinal and lateral directions.

15. The topper of clause 14 in which the resistance varies spatially in a direction substantially perpendicular to a dominant fluid flow direction through the flowpath.

16. The topper of any of clauses 14-15 wherein the nonuniform resistance has a gradient such that the resistance in a target region of the topper is lower at relatively more inboard locations of the topper and higher at relatively more outboard locations.

17. The topper of any of clauses 14 to 16 in which

the flowpath includes fluid flow passages distributed across one of the directions and extending along the other of the directions and wherein the resistance differs from passage to passage and is constant in a given passage in the direction of passage distribution.

18. The topper of clause 17 in which the passages are counterflow passages.

19. The topper of clause 14 in which the nonuniform resistance is attributable to a spatially varying material height.

20. The topper of clause 14 in which the nonuniform resistance is attributable to a spatially varying material density.

21. The topper of clause 14 in which the nonuniform resistance is attributable to a spatially varying porosity.

22. The topper of clause 21 in which the spatially varying porosity is attributable to a spatially varying pore density.

23. The topper of clause 21 in which the spatially varying porosity is attributable to a spatially varying pore size.

24. The topper of clause 14 in which the nonuniform resistance is a flow directing feature.

25. The topper of clause 24 in which the flow directing feature comprises tubules.

26. The topper of clause 14 comprising an insert which exhibits the nonuniform resistance and a ticking that covers the insert.

27. The topper of clause 14 comprising an insert which exhibits the nonuniform resistance and a ticking that encloses the insert.

28. A bed, comprising:

a topper configured to rest atop a mattress, the topper extending in longitudinal and lateral directions and including a fluid flowpath for channeling fluid through the topper from an inlet to an outlet, the flowpath configured to distribute the fluid to a preferred target region of the topper; and

a blower connected to the inlet for supplying air to the flowpath.

29. The bed of clause 28 in which the flowpath is shaped to distribute fluid to the target region.

30. The bed of any of clauses 28-29 in which the target region corresponds approximately to the torso of a supine person substantially laterally centered on the topper.

31. The bed of any of clauses 28-30 in which the flowpath extends predominantly laterally.

32. The bed of any of clauses 28-30 in which the flowpath extends predominantly longitudinally.

33. The bed of any of clauses 28-32 in which the fluid flowpath is an insert and wherein a ticking encloses the insert.

34. The bed of any of claims 28-32 in which the fluid flowpath is an insert and wherein a ticking covers the insert.

35. The bed of any of clauses 28-34 in which the flowpath has a keyhole shape.

36. The bed of any of clauses 28-35 in which the flowpath includes fluid passages distributed across one of the directions and extending along the other of the directions.

37. The bed of clause 36 in which the passages are counterflow passages.

38. The bed of clause 36 including sensors distributed on the bed, the sensors being capable of sensing a parameter useable for determining weight distribution of an occupant of the bed.

39. The bed of clause 36 including a controller which receives a signal representing a value of the sensed parameter and causes fluid to be metered to the passages in response to the signal such that a larger proportion of fluid supplied to the flowpath is directed to the target region and a smaller proportion bypasses the target region.

40. The bed of clause 36 in which signals representative of the sensed parameter are generated for use by an off-board controller capable of causing fluid to be metered to the passages in response to the signals such that a larger proportion of fluid flowing through the flowpath is directed to the target region and a smaller proportion bypasses the target region.

41. The bed of clause 28 wherein the flowpath is configured to distribute the fluid to a preferred target region of the topper as a result of exhibiting a nonuniform resistance to fluid flow in at least one of the longitudinal and lateral directions; and a blower connected to the inlet for supplying air to the flowpath.

42. The bed of clause 41 in which the resistance varies spatially in a direction substantially perpendicular to a dominant fluid flow direction through the flowpath.

43. The bed of any of clauses 41-42 wherein the nonuniform resistance has a gradient such that the resistance in a target region of the topper is lower at relatively more inboard locations of the topper and higher at relatively more outboard locations.

44. The bed of any of clauses 41-43 in which the flowpath includes fluid flow passages distributed across one of the directions and extending along the other of the directions and in which the resistance differs from passage to passage and is constant in a given passage in the direction of passage distribution.

45. The bed of any of clauses 41-44 in which the nonuniform resistance is attributable to a spatially varying material height.

46. The bed of any of clauses 41-44 in which the nonuniform resistance is attributable to a spatially varying material density.

47. The bed of any of clauses 41-44 in which the nonuniform resistance is attributable to a spatially varying porosity.

48. The bed of clause 47 in which the spatially varying porosity is attributable to a spatially varying pore density.

49. The bed of clause 47 in which the spatially varying porosity is attributable to a spatially varying pore size.

50. The bed of clause 41 in which the nonuniform resistance is a flow directing feature.

51. The bed of clause 50 in which the flow directing feature comprises tubules.

52. The bed of clause 41 in which the topper comprises an insert which exhibits the nonuniform resistance and a ticking that covers the insert.

53. The bed of clause 41 in which the topper comprises an insert which exhibits the nonuniform resistance and a ticking that encloses the insert.

54. The bed of clause 27 wherein the flowpath is configured to distribute the fluid to a preferred target region of the topper as a result of exhibiting a monotonically varying resistance to fluid flow in at least one of the longitudinal and lateral directions, the resistance being configured to preferentially drive fluid flow through the topper so that a larger proportion of the fluid flowing through the topper flows under a target region and a relatively smaller portion bypasses the target region; and a blower connected to the inlet for supplying air to the flowpath.

55. The bed of clause 54 in which the resistance varies spatially in a direction substantially perpendicular to a dominant fluid flow direction through the flowpath.

56. The bed of clause 54 wherein the nonuniform resistance has a gradient such that the resistance in the target region of the topper is lower at relatively more inboard locations of the topper and higher at relatively more outboard locations.

57. The bed of clause 54 in which the flowpath includes fluid flow passages distributed across one of the directions and extending along the other of the directions.

58. The bed of clause 57 in which the resistance differs from passage to passage and is constant in a given passage in the direction of passage distribution.

59. The bed of clause 57 in which the passages are counterflow passages.

60. The bed of clause 54 in which the nonuniform resistance is attributable to a spatially varying material height.

61. The bed of clause 54 in which the nonuniform resistance is attributable to a spatially varying material density.

62. The bed of clause 54 in which the nonuniform resistance is attributable to a spatially varying poros-

ity.

63. The bed of clause 62 in which the spatially varying porosity is attributable to a spatially varying pore density.

64. The bed of clause 62 in which the spatially varying porosity is attributable to a spatially varying pore size.

65. The bed of clause 54 in which the nonuniform resistance is a flow directing feature.

66. The bed of clause 65 in which the flow directing feature comprises tubules.

67. The bed of clause 54 in which the topper comprises an insert which exhibits the nonuniform resistance and a ticking that covers the insert.

68. The bed of clause 54 in which the topper comprises an insert which exhibits the nonuniform resistance and a ticking that encloses the insert.

Claims

1. A topper for a bed, the topper extending in longitudinal and lateral directions and including a fluid flowpath for channeling fluid through the topper from an inlet to an outlet, the flowpath configured to distribute the fluid to a preferred target region of the topper as a result of exhibiting a nonuniform resistance to fluid flow in at least one of the longitudinal and lateral directions.
2. The topper of claim 1 in which the flowpath is configured to distribute the fluid to a preferred target region of the topper as a result of also being shaped to distribute fluid to the target region.
3. The topper of either claim 1 or claim 2 in which the target region corresponds approximately to the torso of a supine person substantially laterally centered on the topper.
4. The topper of any preceding claim in which the flowpath extends predominantly laterally.
5. The topper of any of claims 1 to 3 in which the flowpath extends predominantly longitudinally.
6. The topper of any preceding claim in which the fluid flowpath is an insert and wherein a ticking encloses or covers the insert.
7. The topper of any preceding claim in which the flowpath includes fluid passages distributed across one of the directions and extending along the other of the directions.
8. The topper of claim 7 in which the passages are counterflow passages.

9. The topper of any preceding claim in which the resistance varies spatially in a direction substantially perpendicular to a dominant fluid flow direction through the flowpath. 5
10. The topper of any preceding claim wherein the non-uniform resistance has a gradient such that the resistance is lower at relatively more inboard locations of the topper and higher at relatively more outboard locations. 10
11. The topper of any preceding claim in which the flowpath includes at least two fluid flow passages distributed across one of the directions and extending along the other of the directions and wherein the resistance differs from passage to passage and is constant in a given passage in the direction of passage distribution. 15
12. The topper of claim 11 in which the passages are counterflow passages. 20
13. The topper of any preceding claim in which the non-uniform resistance is attributable to a spatially varying material height, or a spatially varying material density, or a spatially varying porosity, or a spatially varying pore density, or a spatially varying pore size. 25
14. A topper of any preceding claim wherein the resistance varies monotonically in at least one of the longitudinal and lateral directions to preferentially drive fluid flow through the topper so that a larger proportion of the fluid flowing through the topper flows under the target region and a relatively smaller portion bypasses the target region. 30
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15. A bed including a mattress and a topper of any preceding claim. 40

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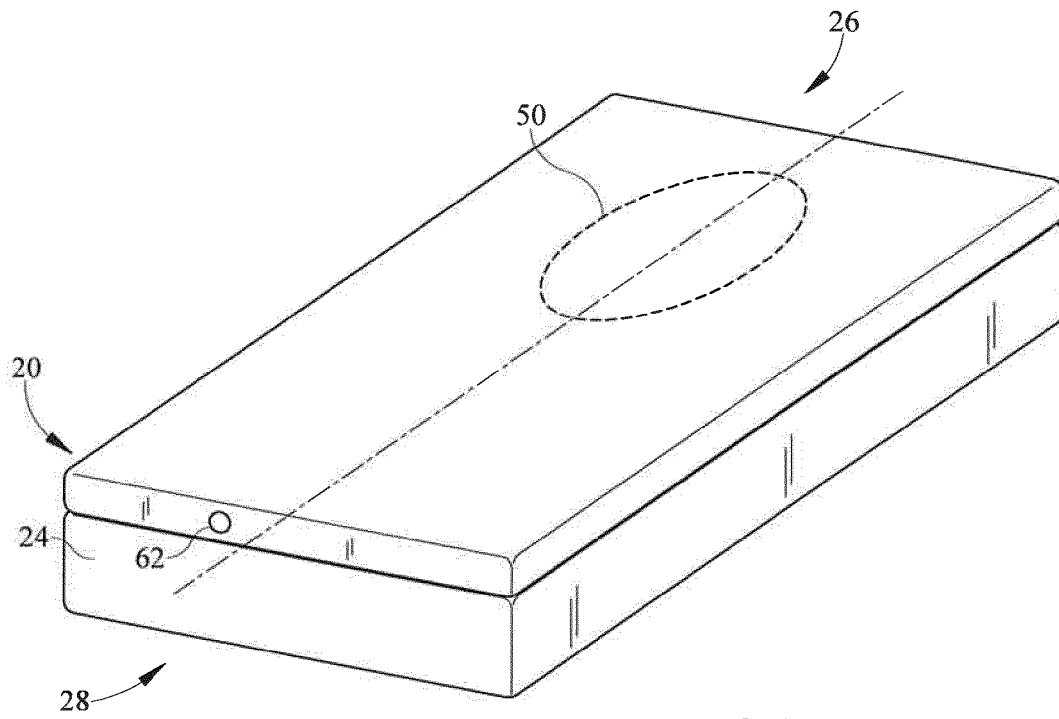


FIG. 1

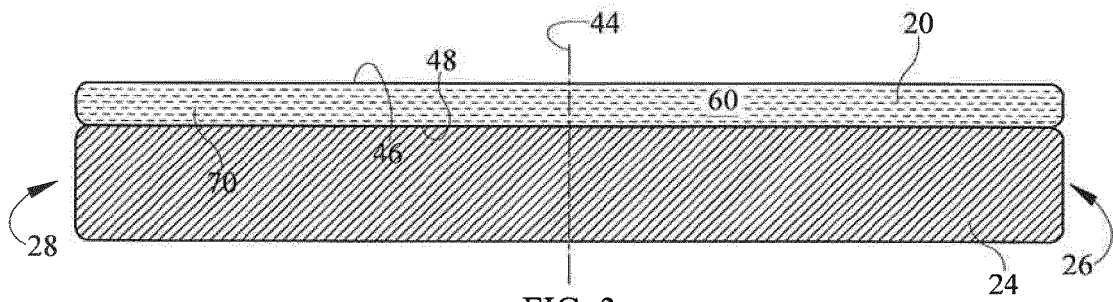


FIG. 3

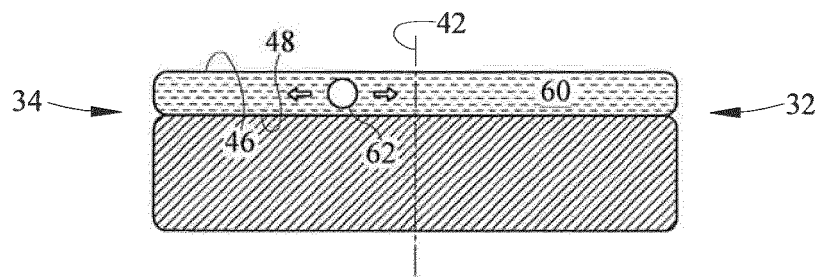


FIG. 4

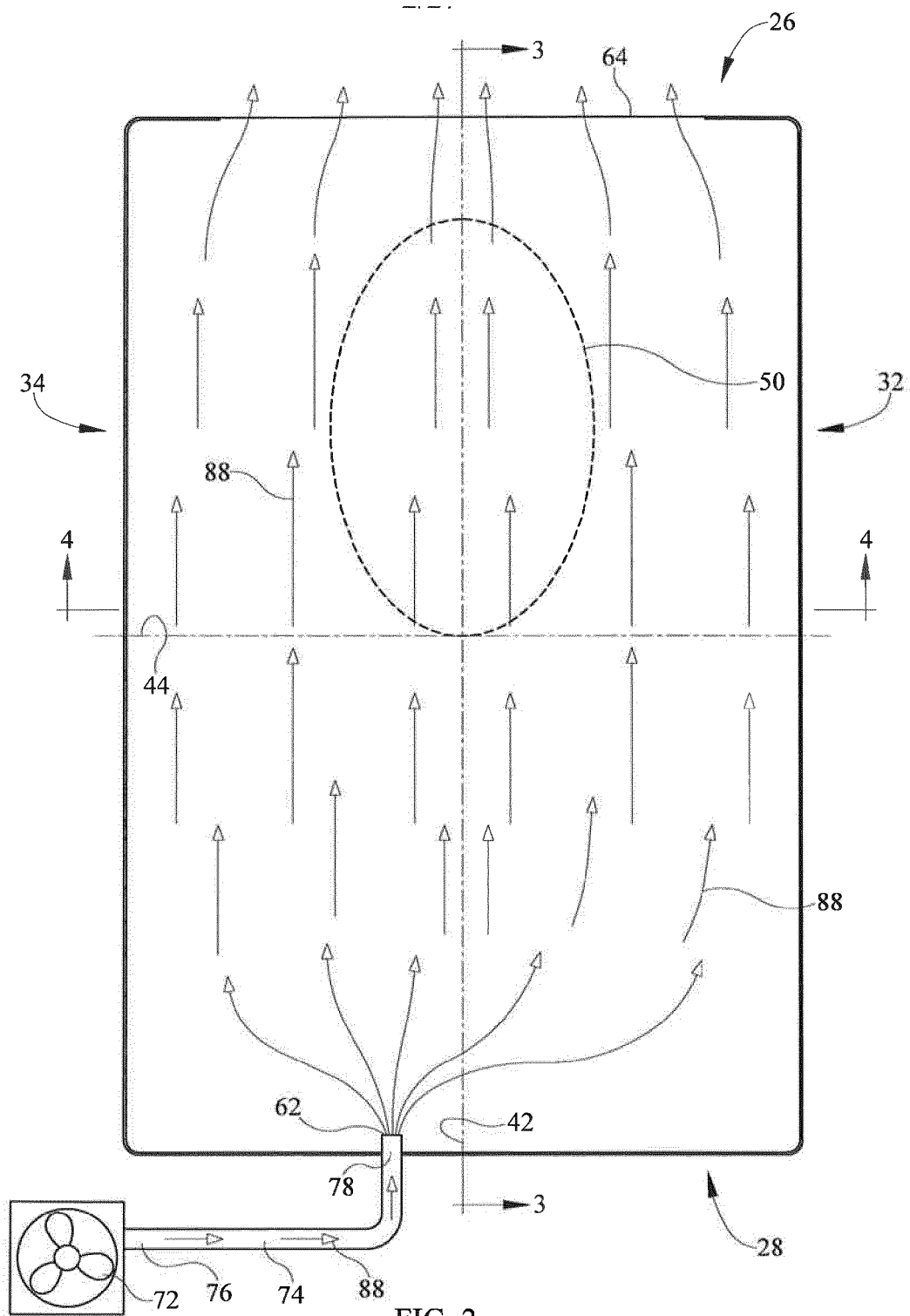
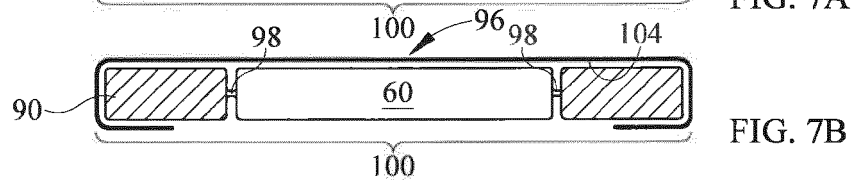
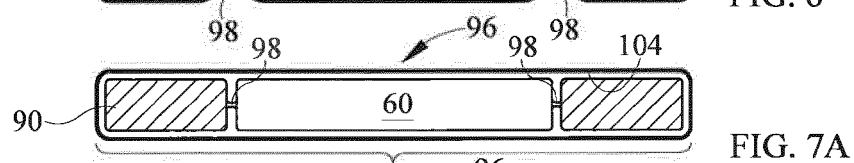
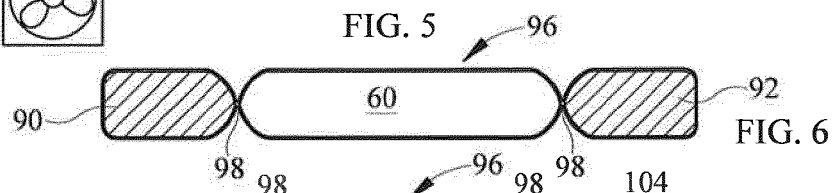
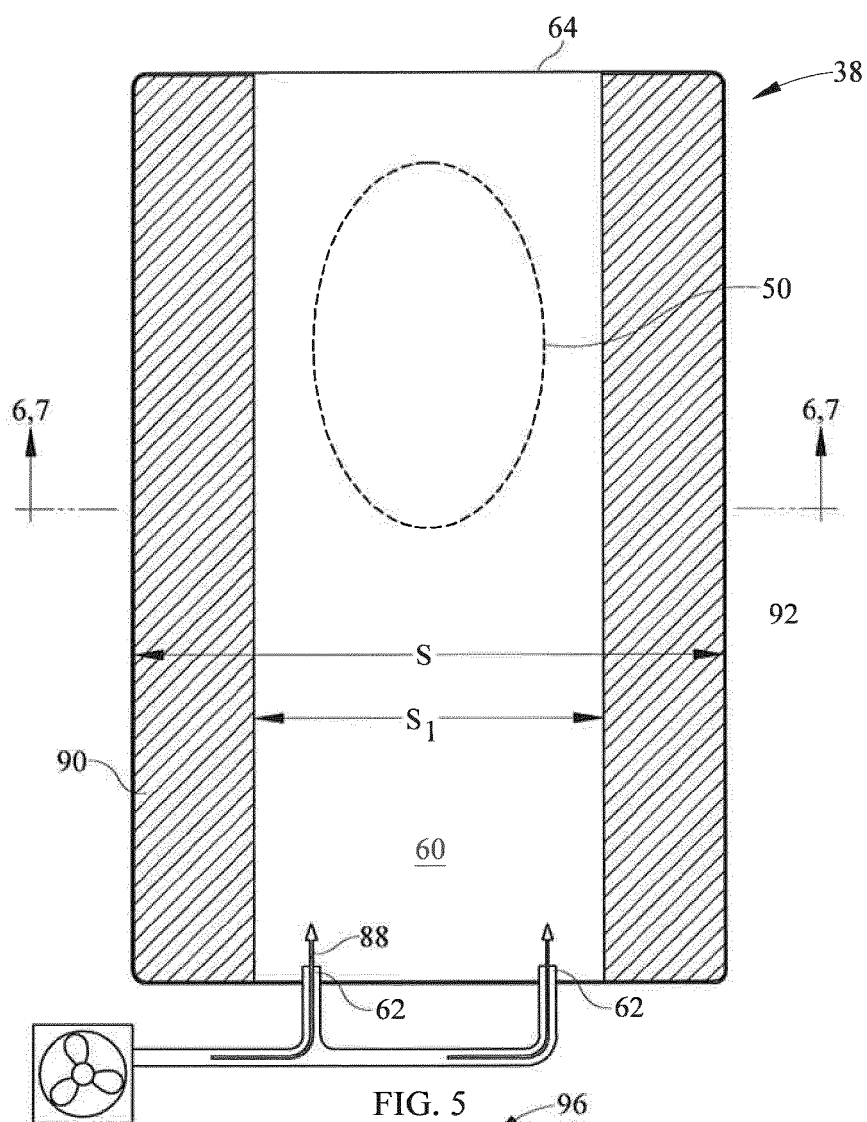


FIG. 2



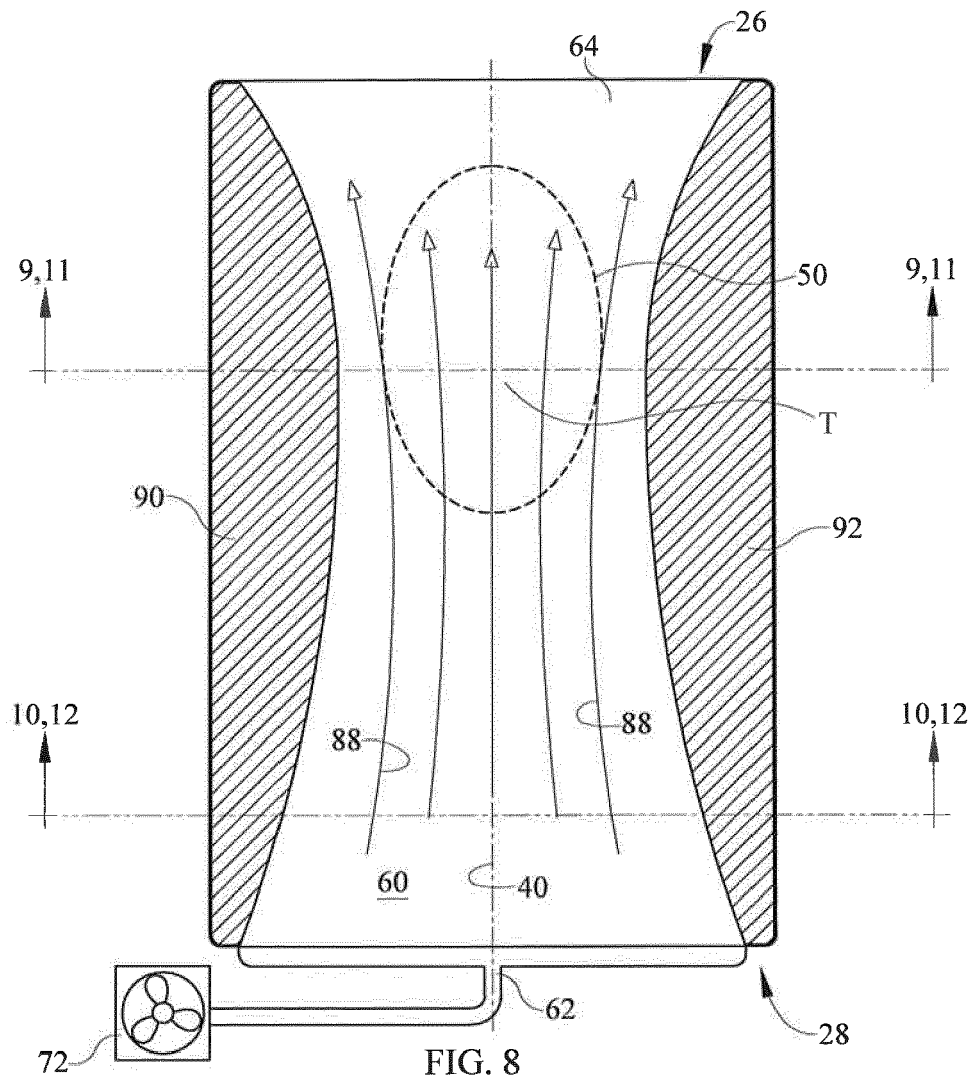


FIG. 8



FIG. 9



FIG. 10



FIG. 11

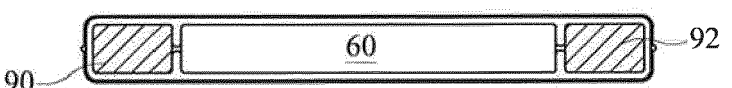


FIG. 12

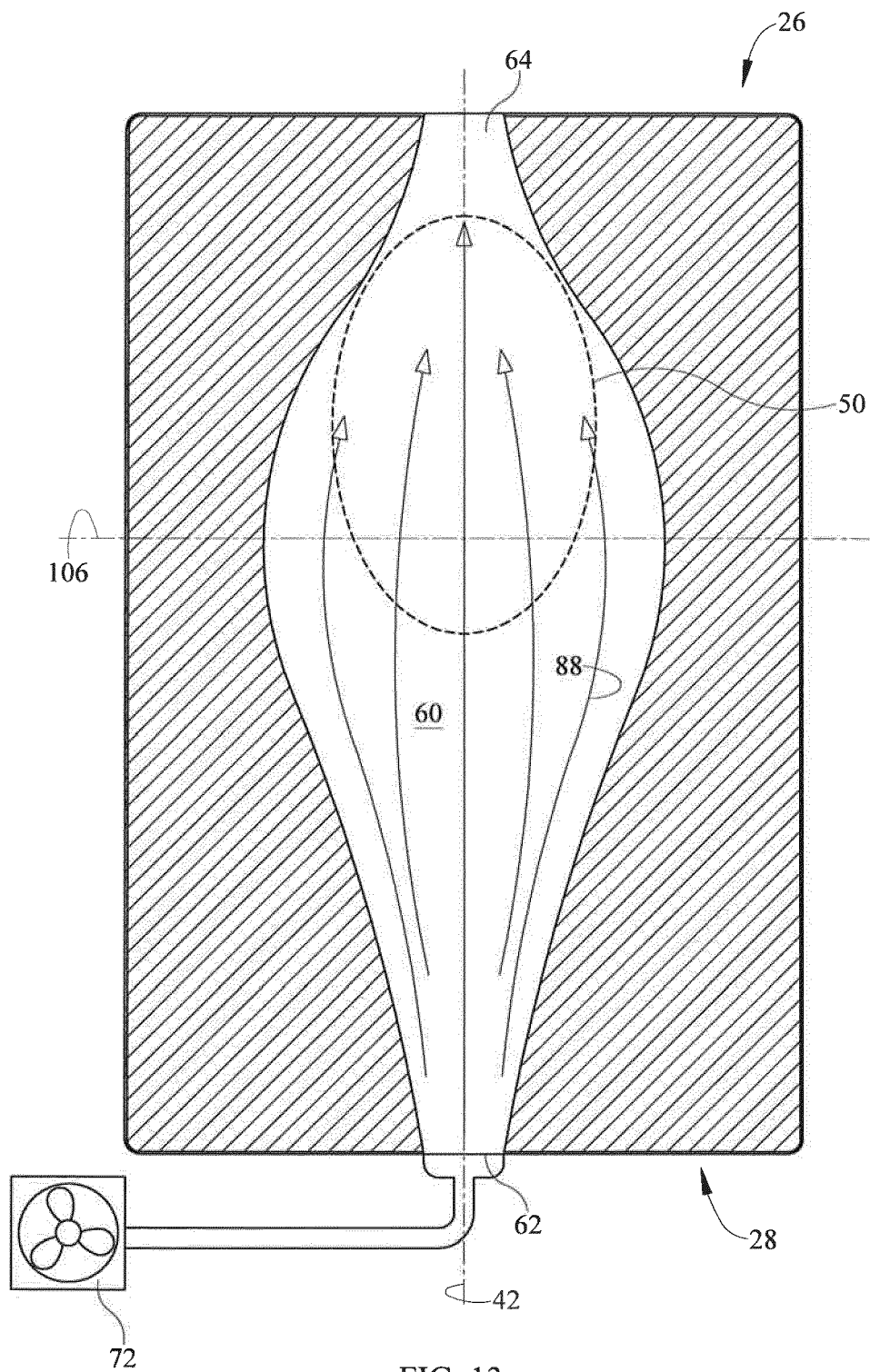


FIG. 13

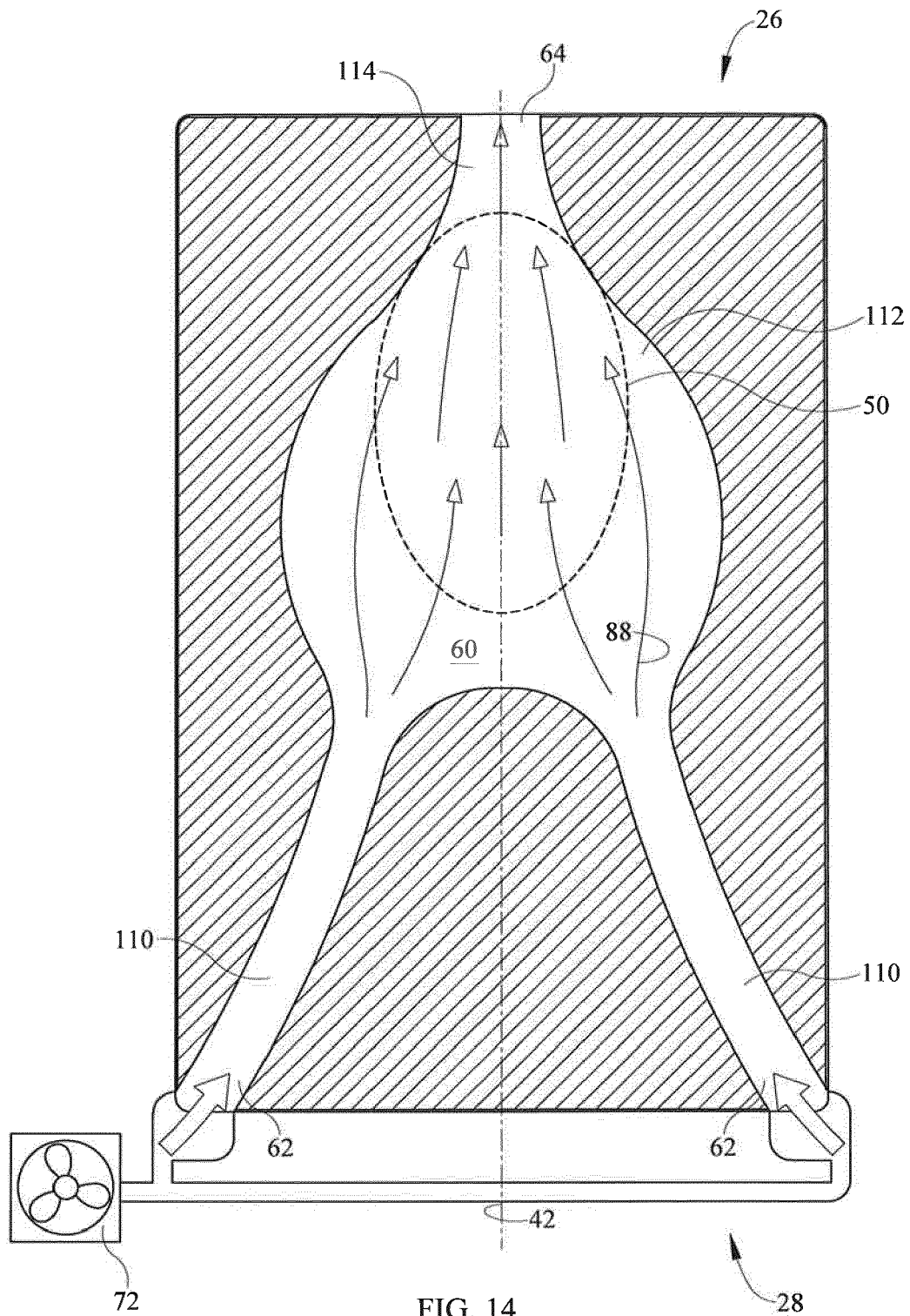


FIG. 14

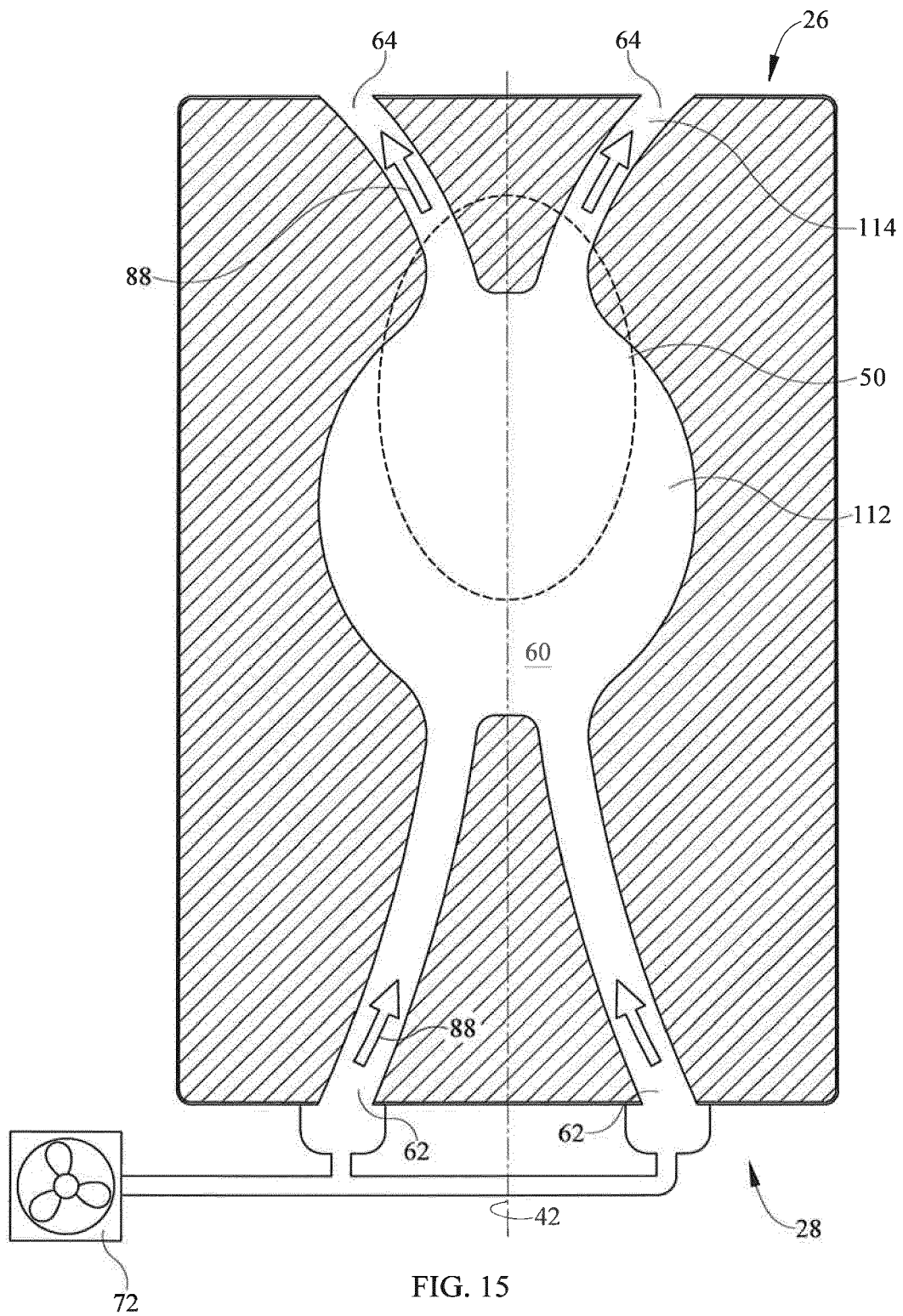


FIG. 15

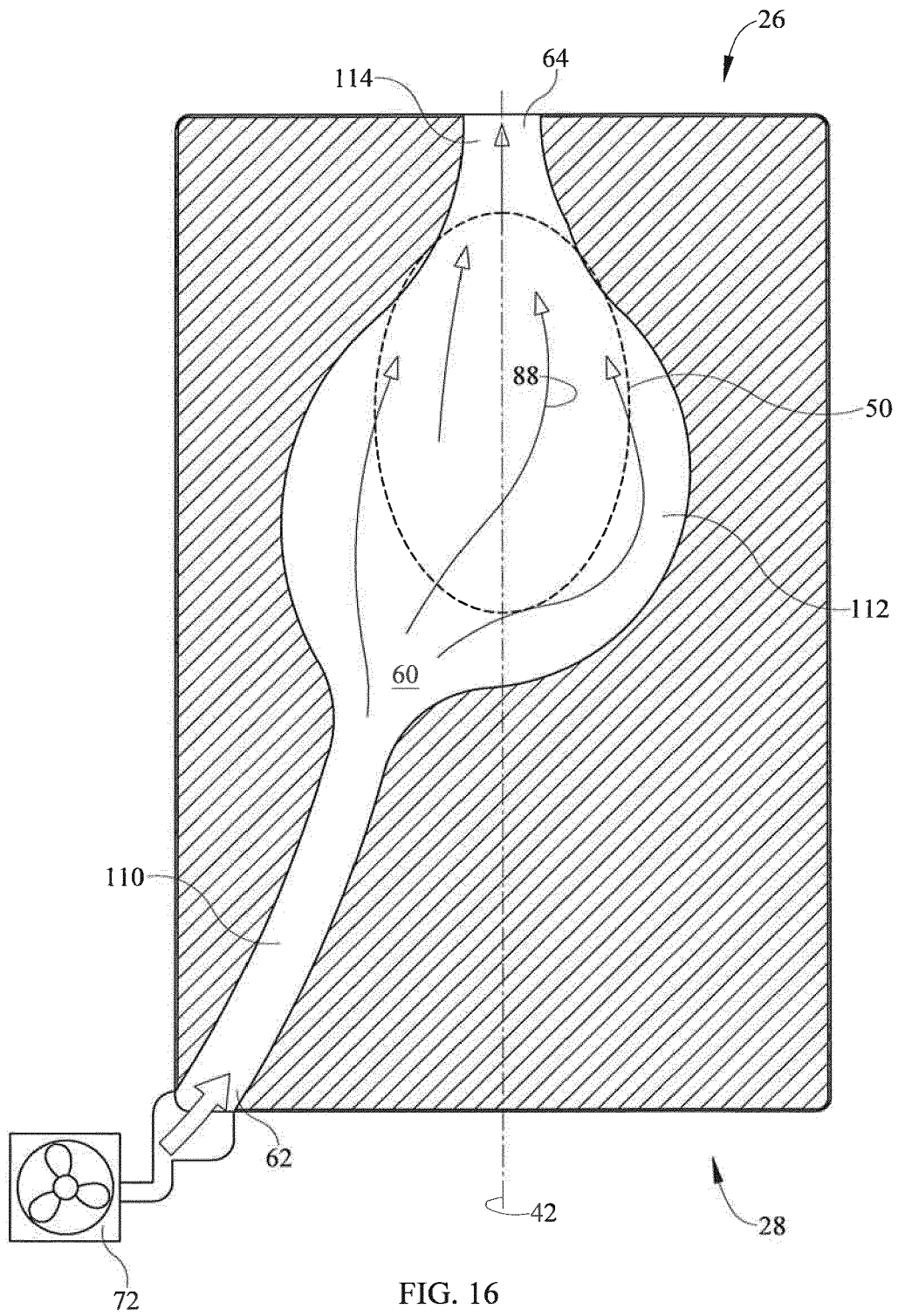


FIG. 16

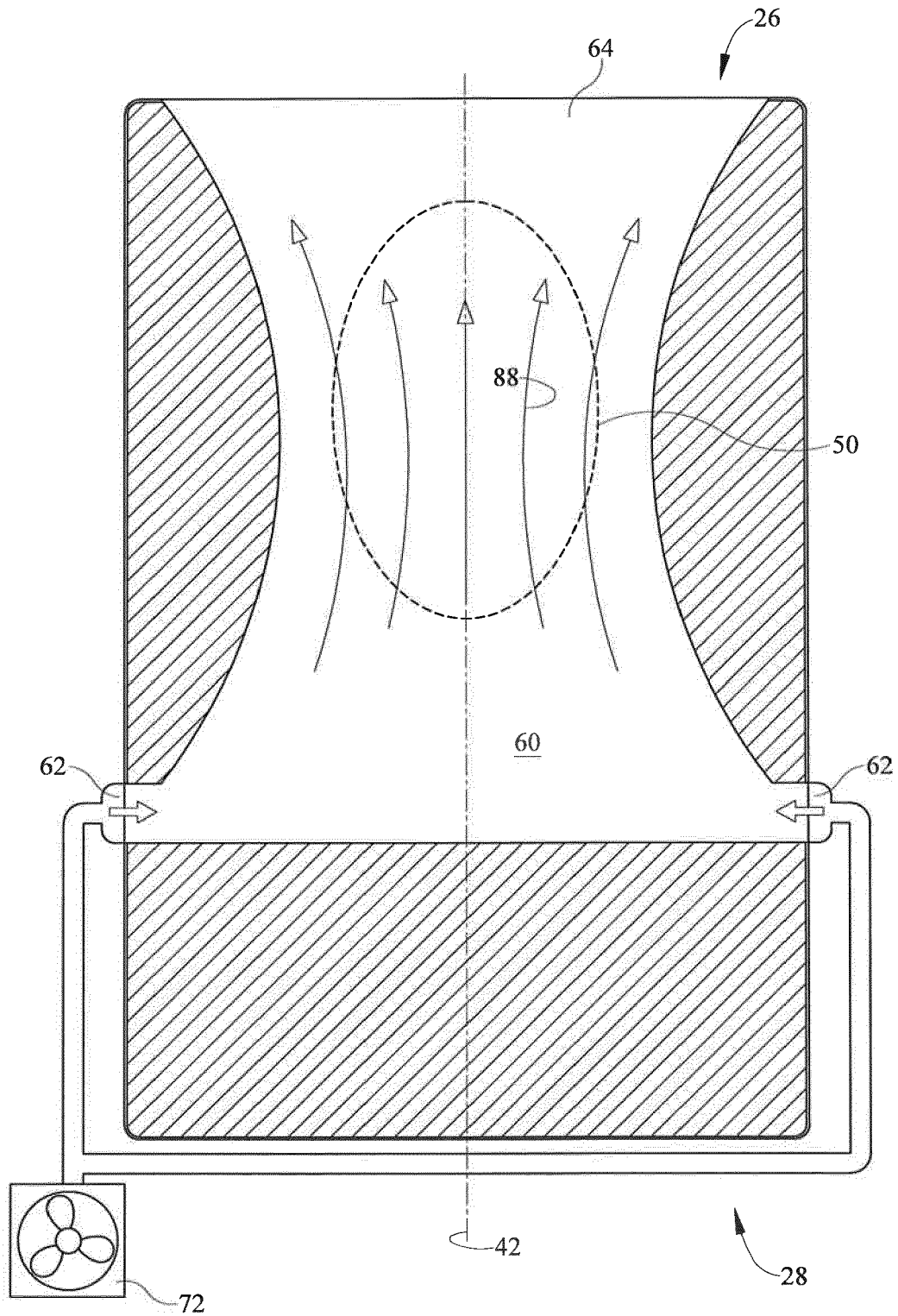


FIG. 17

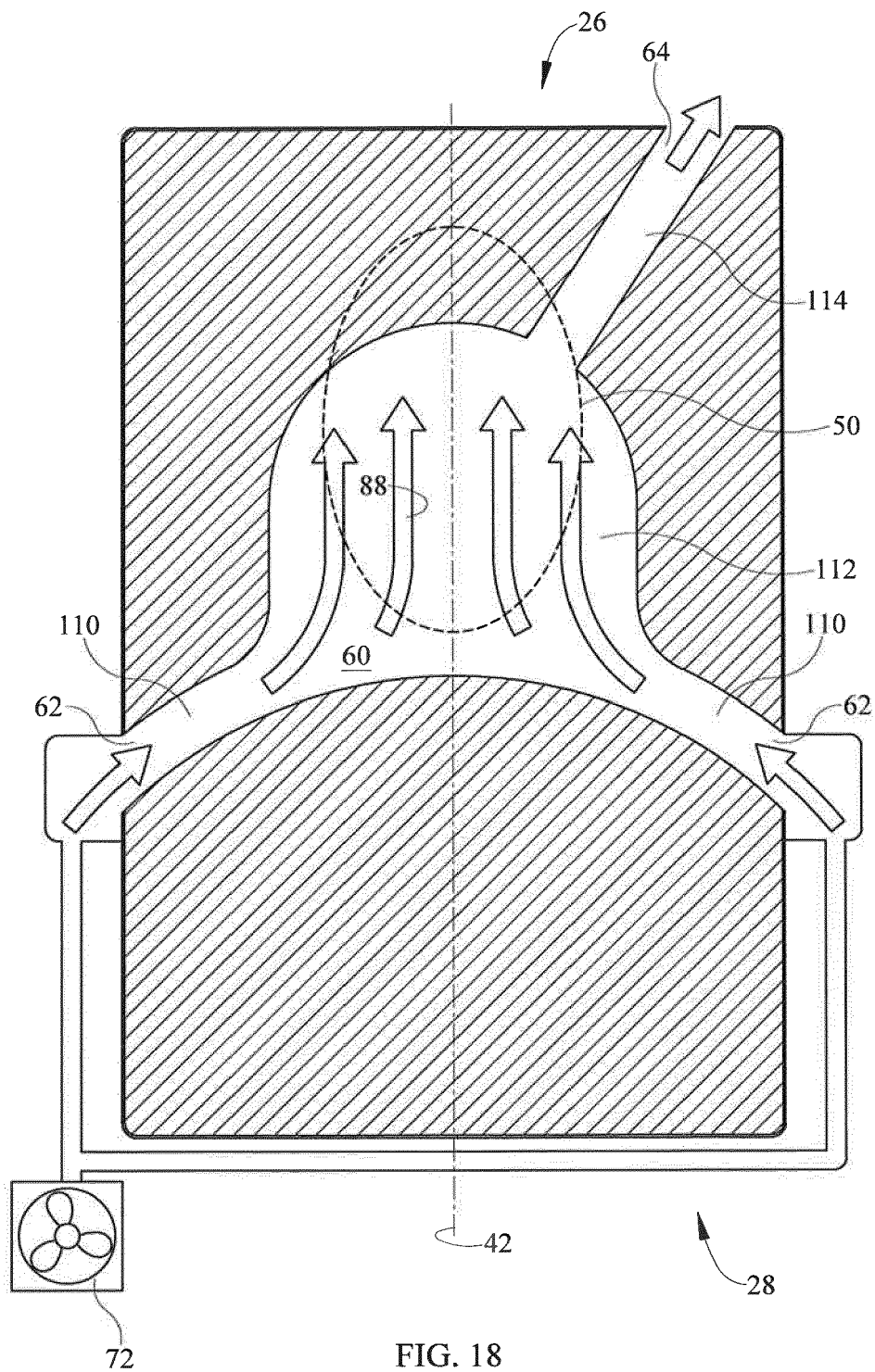


FIG. 18

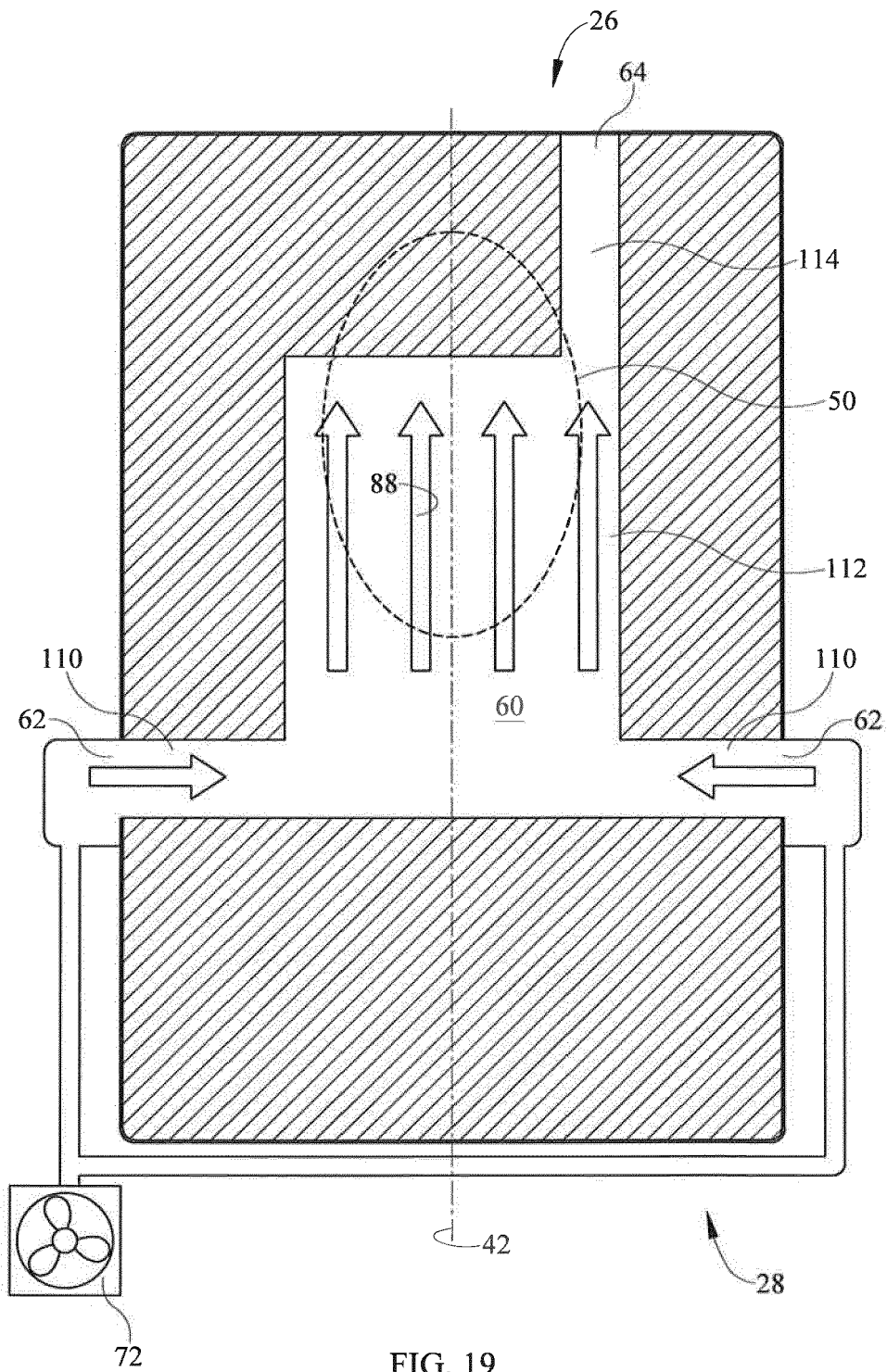


FIG. 19

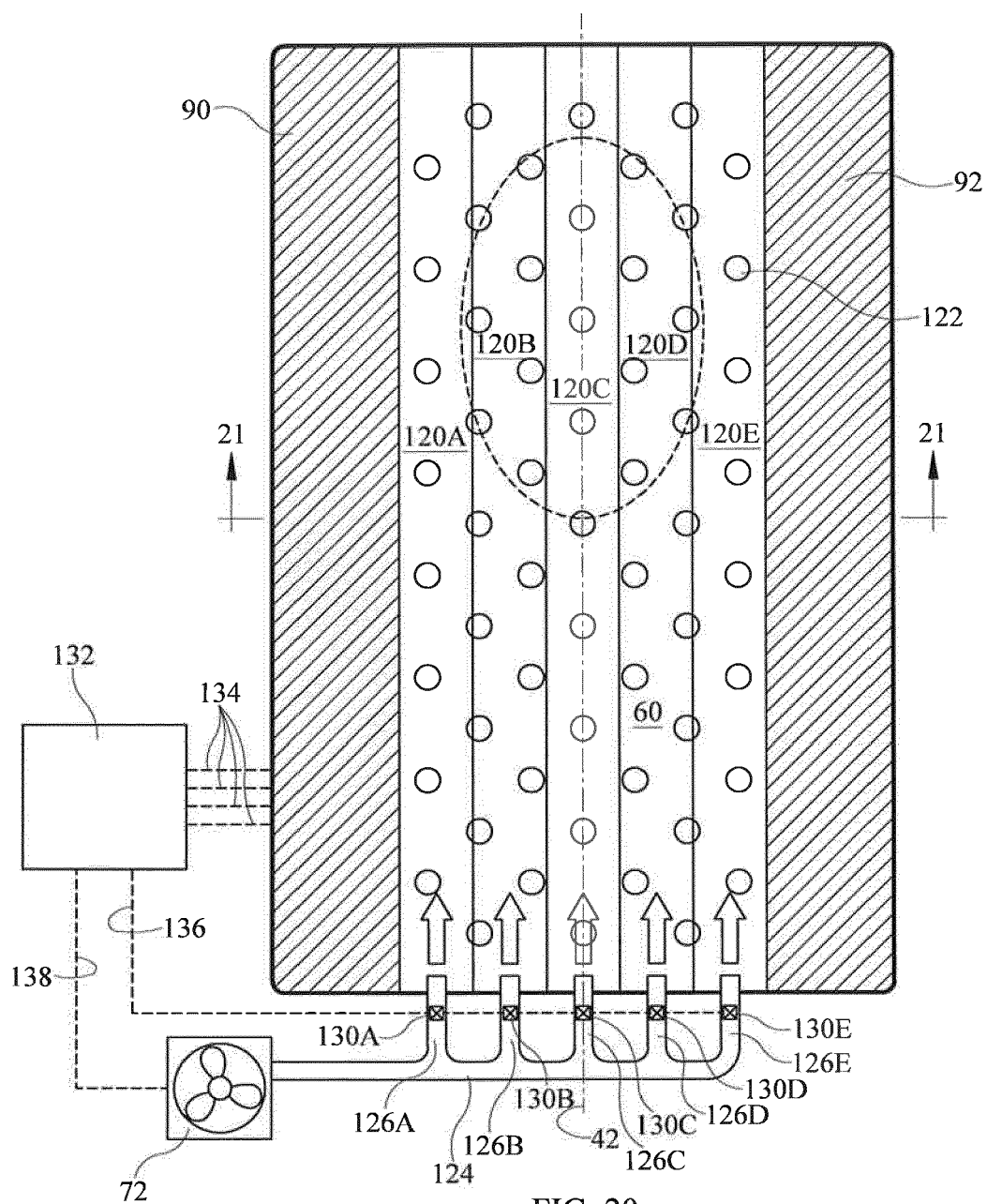


FIG. 20

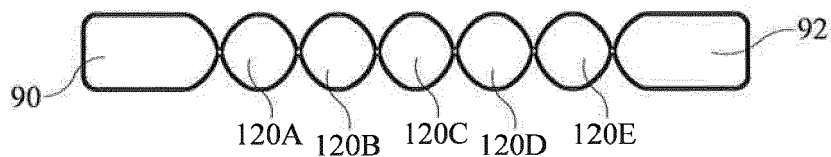


FIG. 21

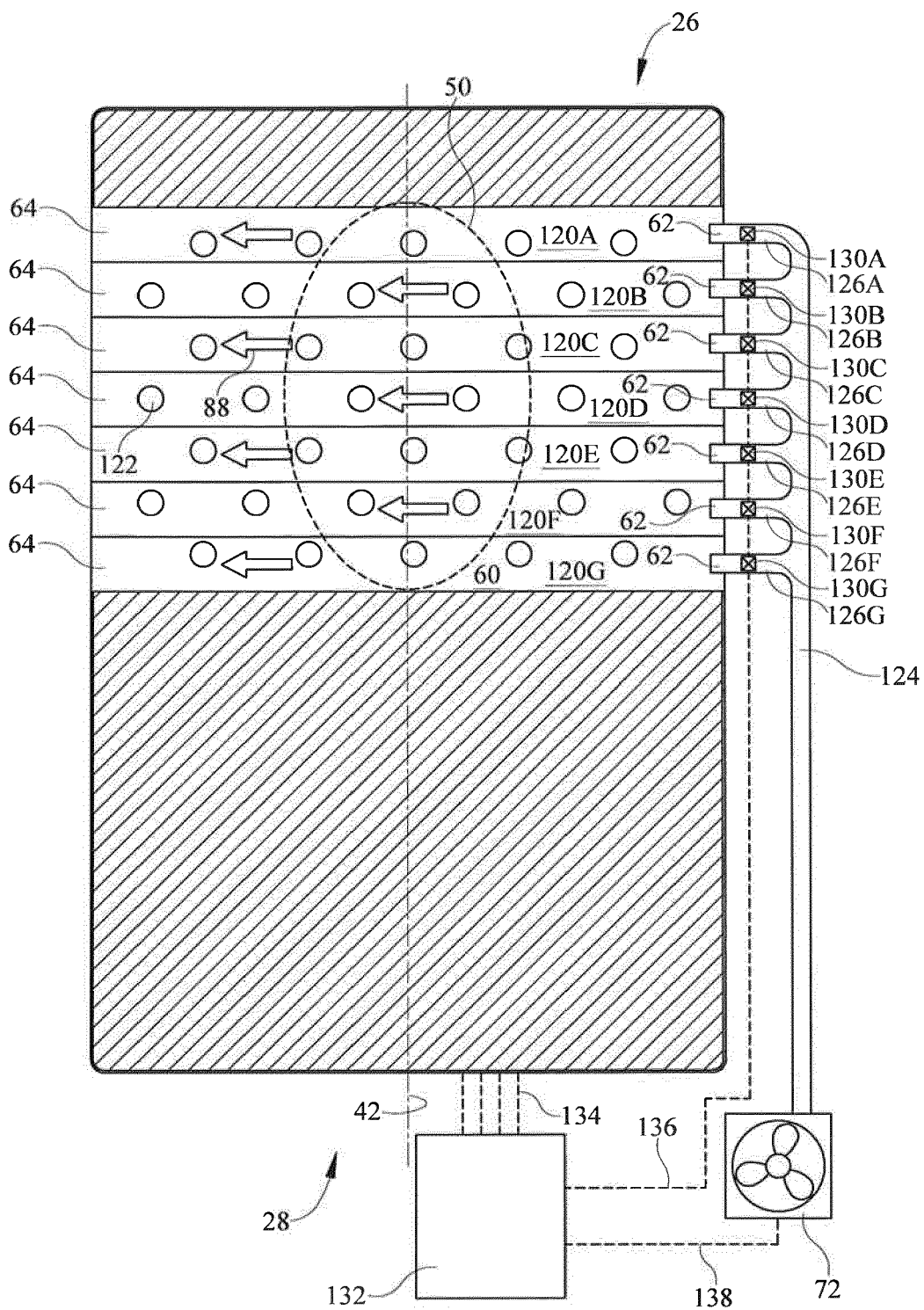


FIG. 22

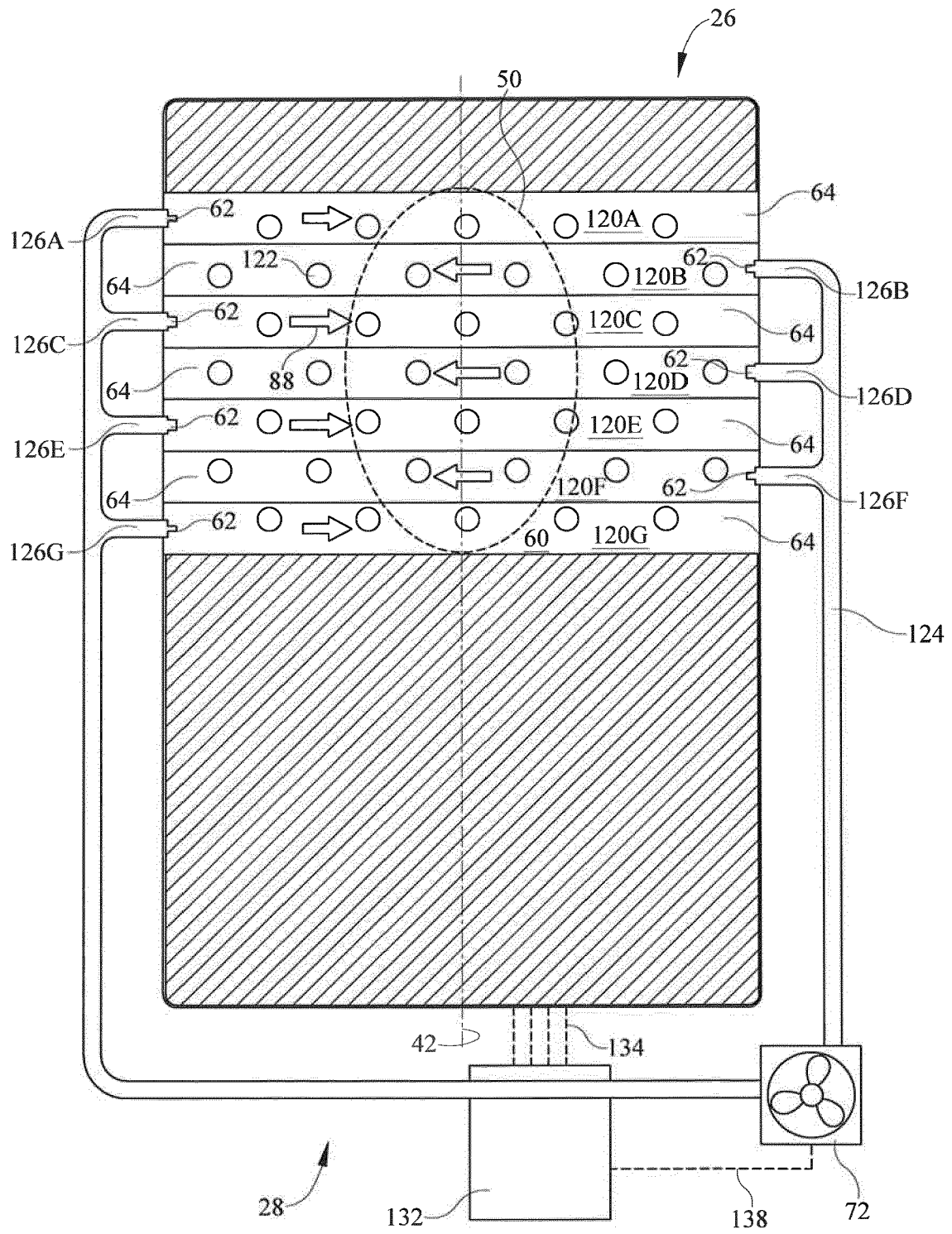


FIG. 23

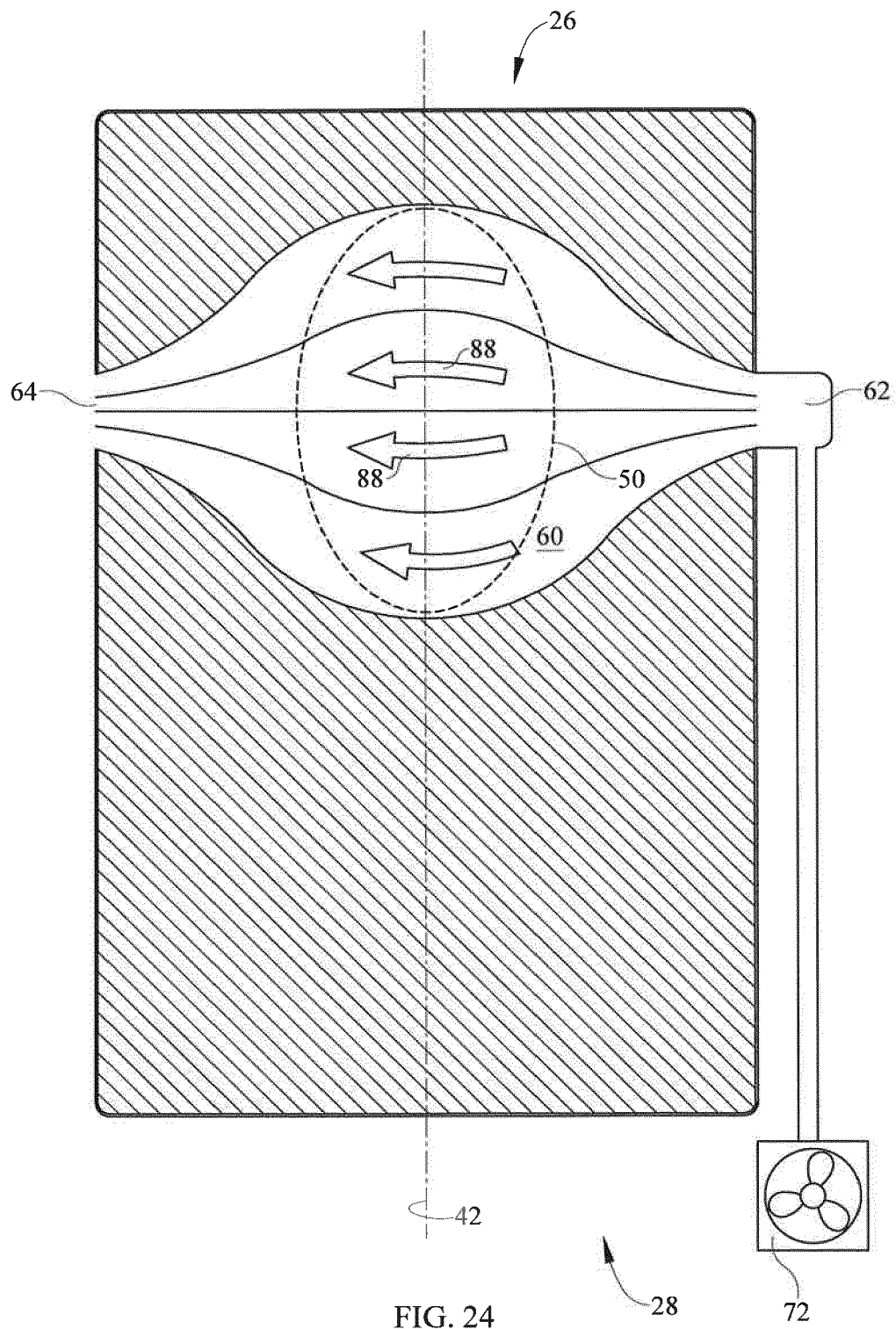
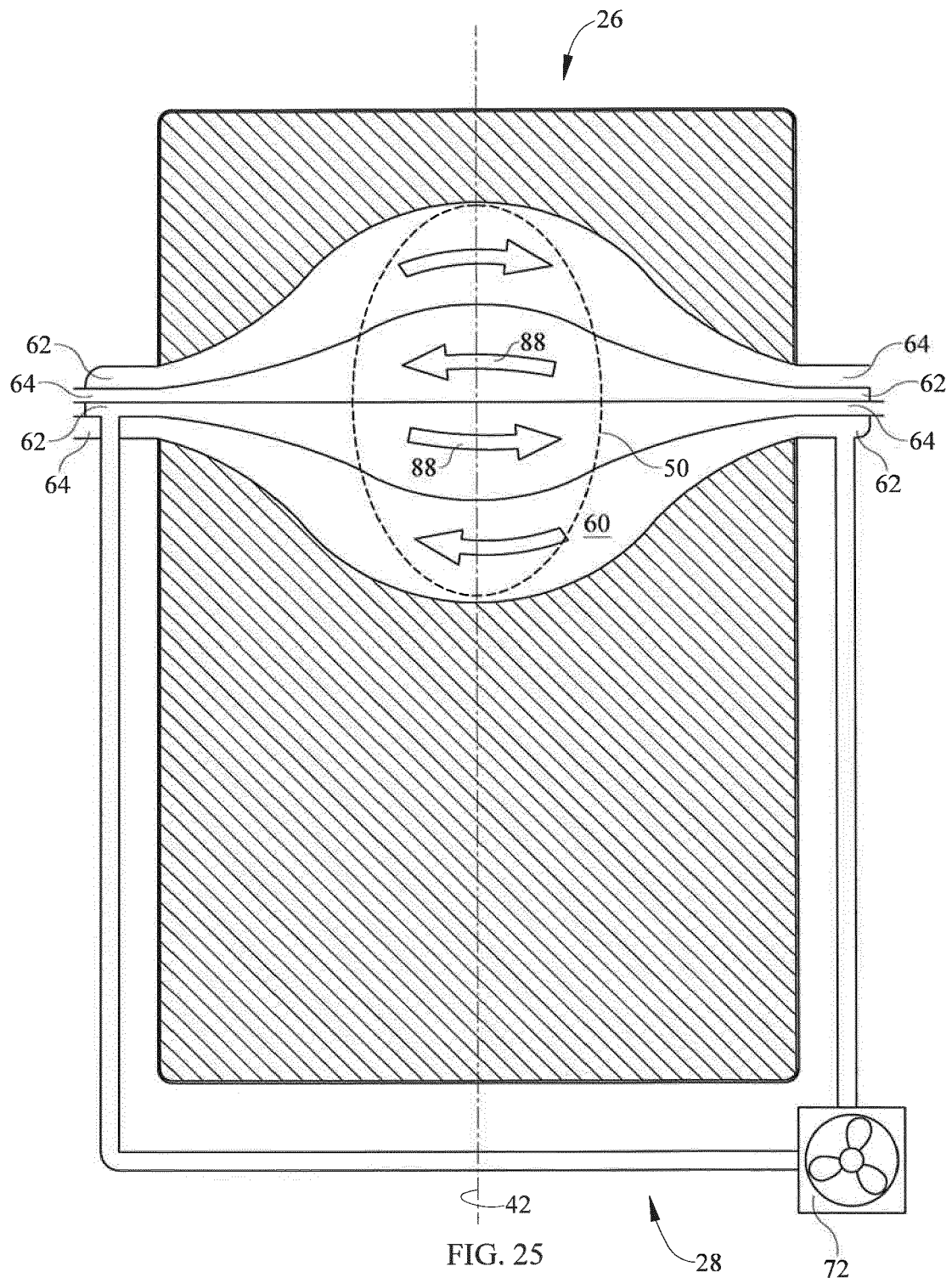
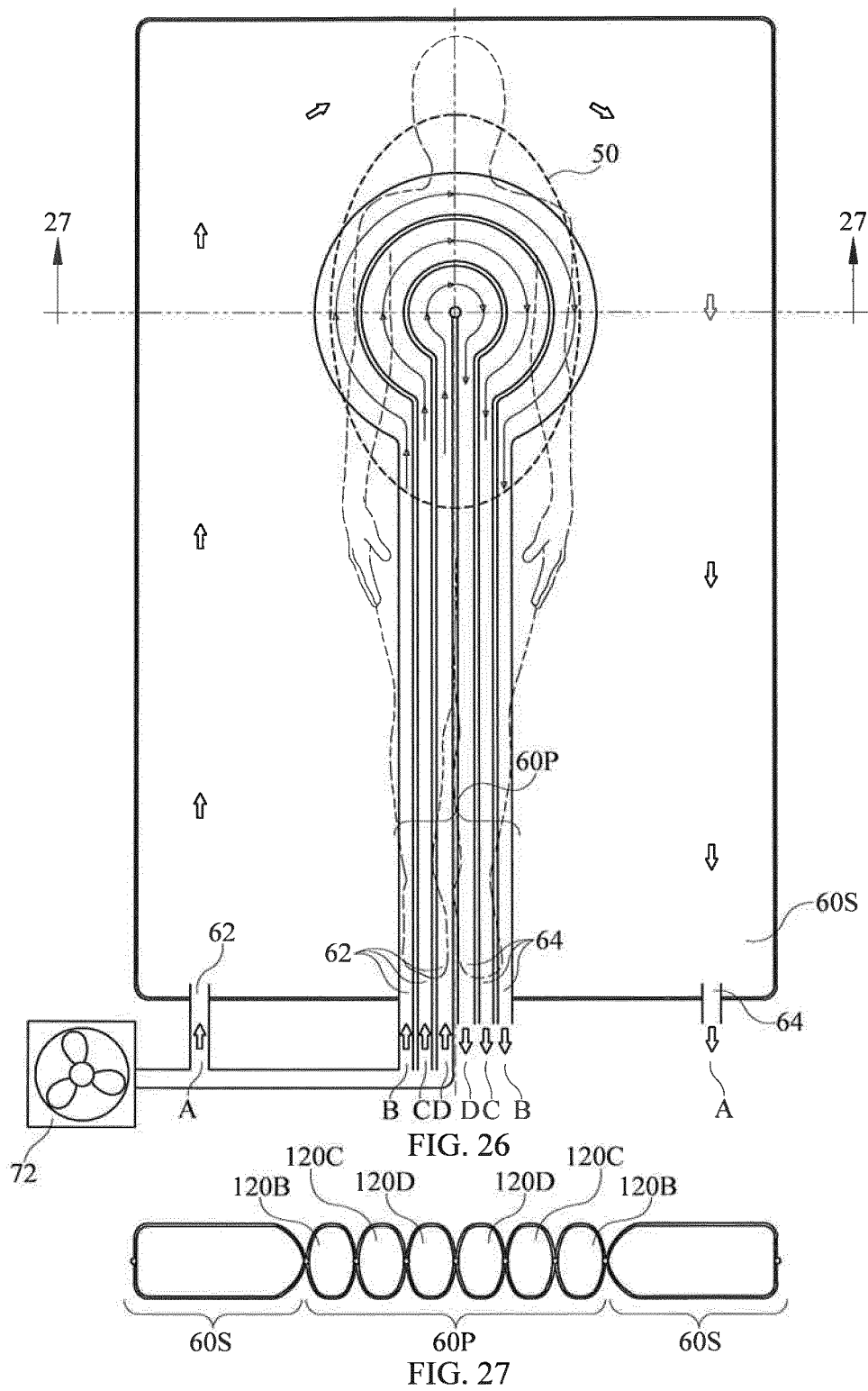


FIG. 24





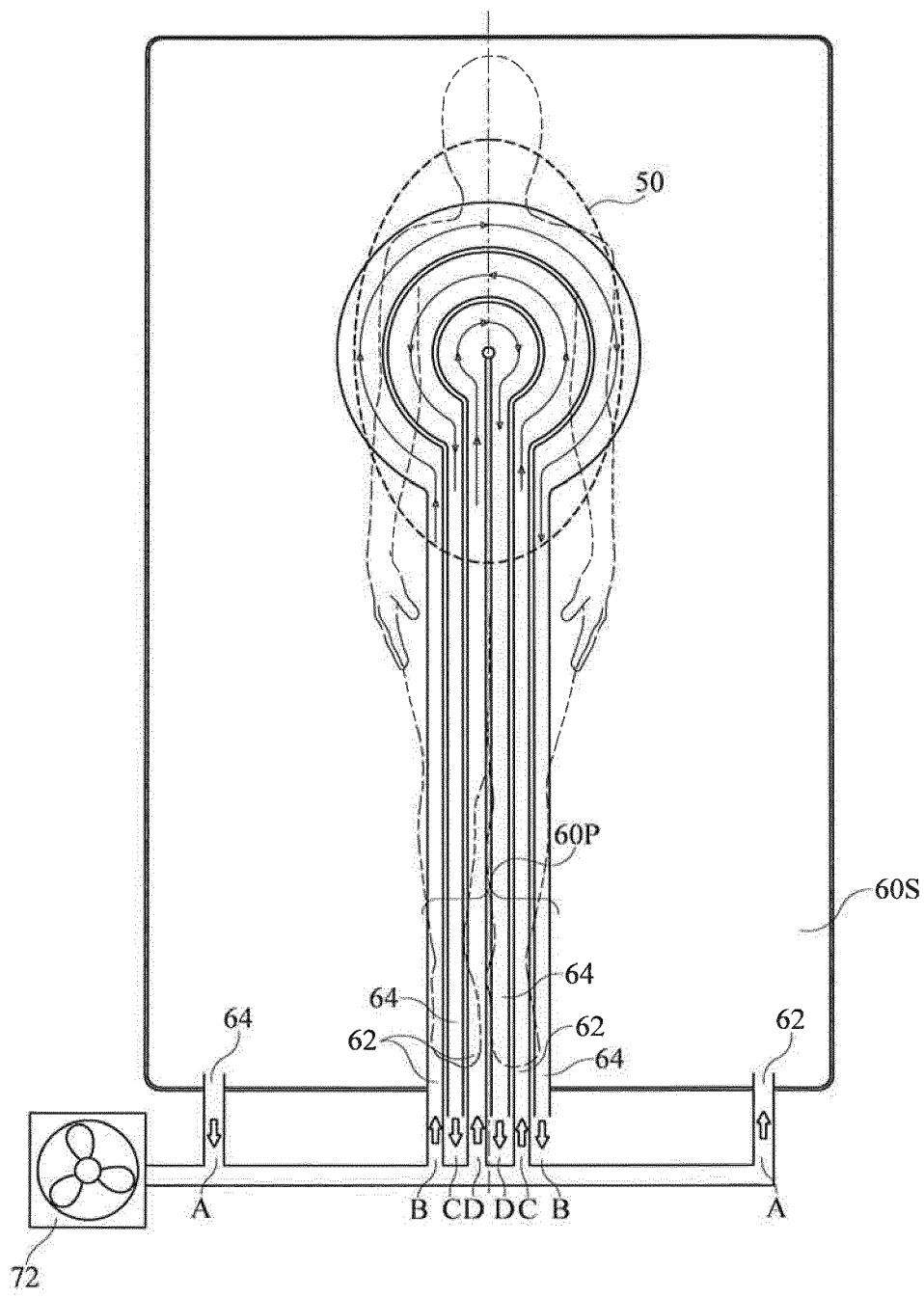


FIG. 28

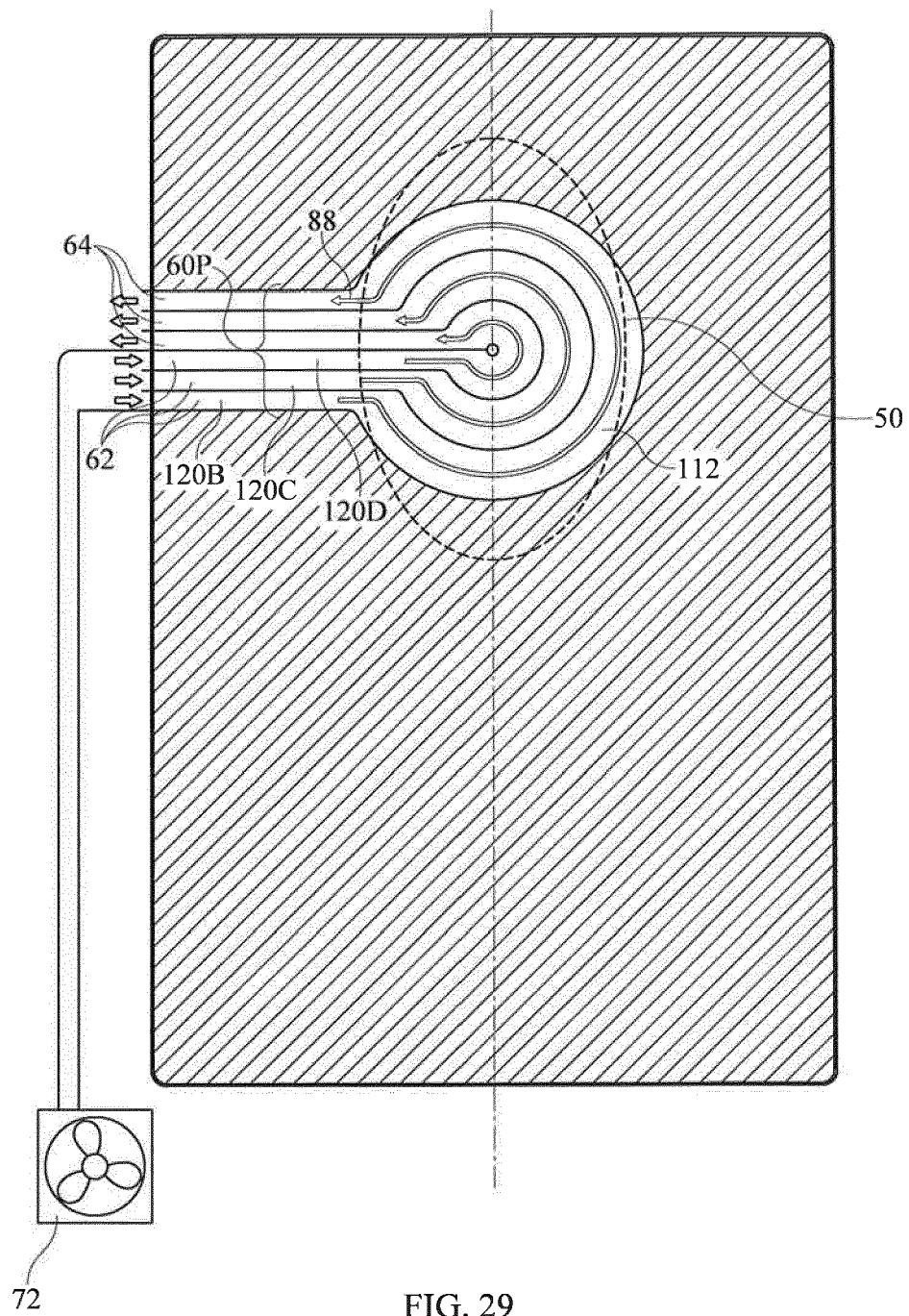
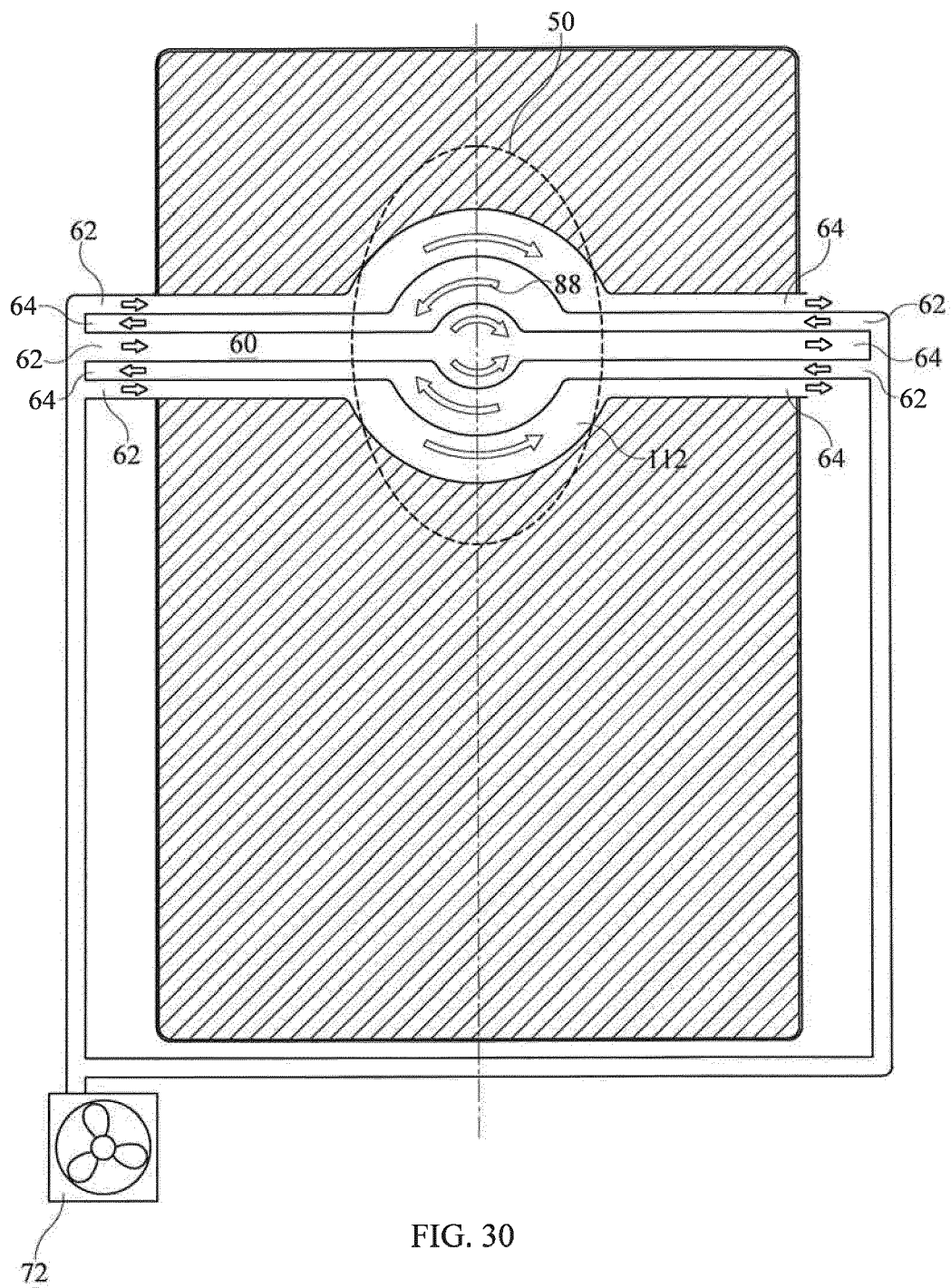


FIG. 29



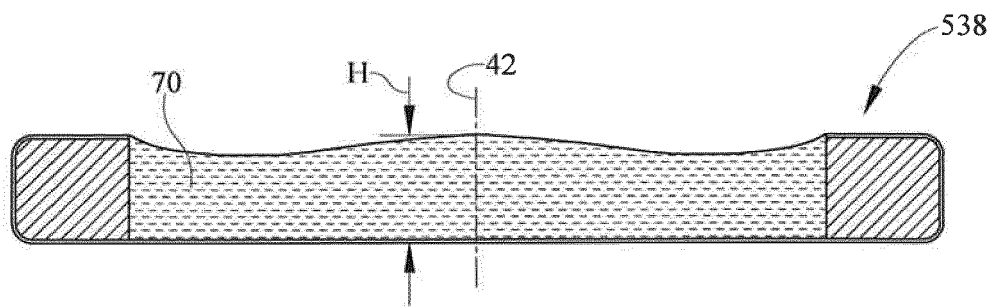


FIG. 31

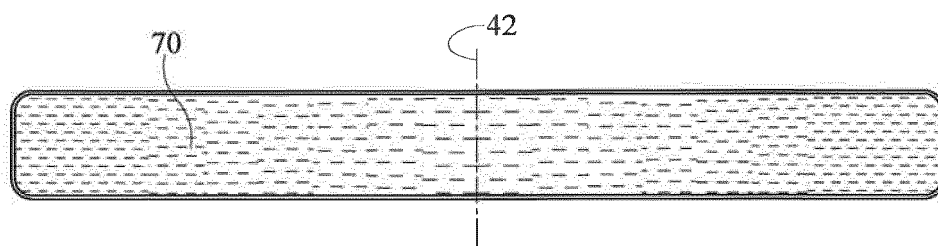


FIG. 32

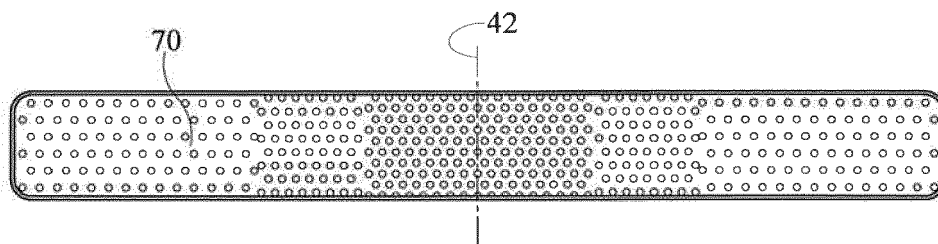


FIG. 33

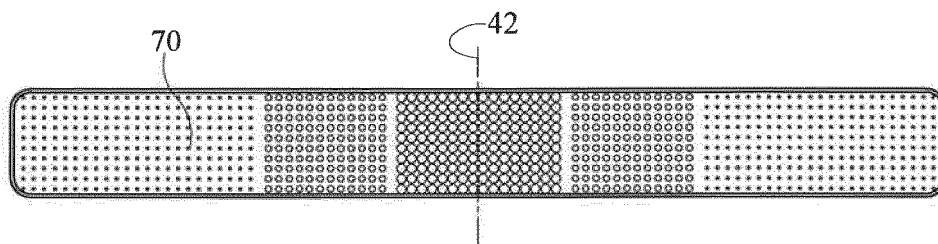


FIG. 34

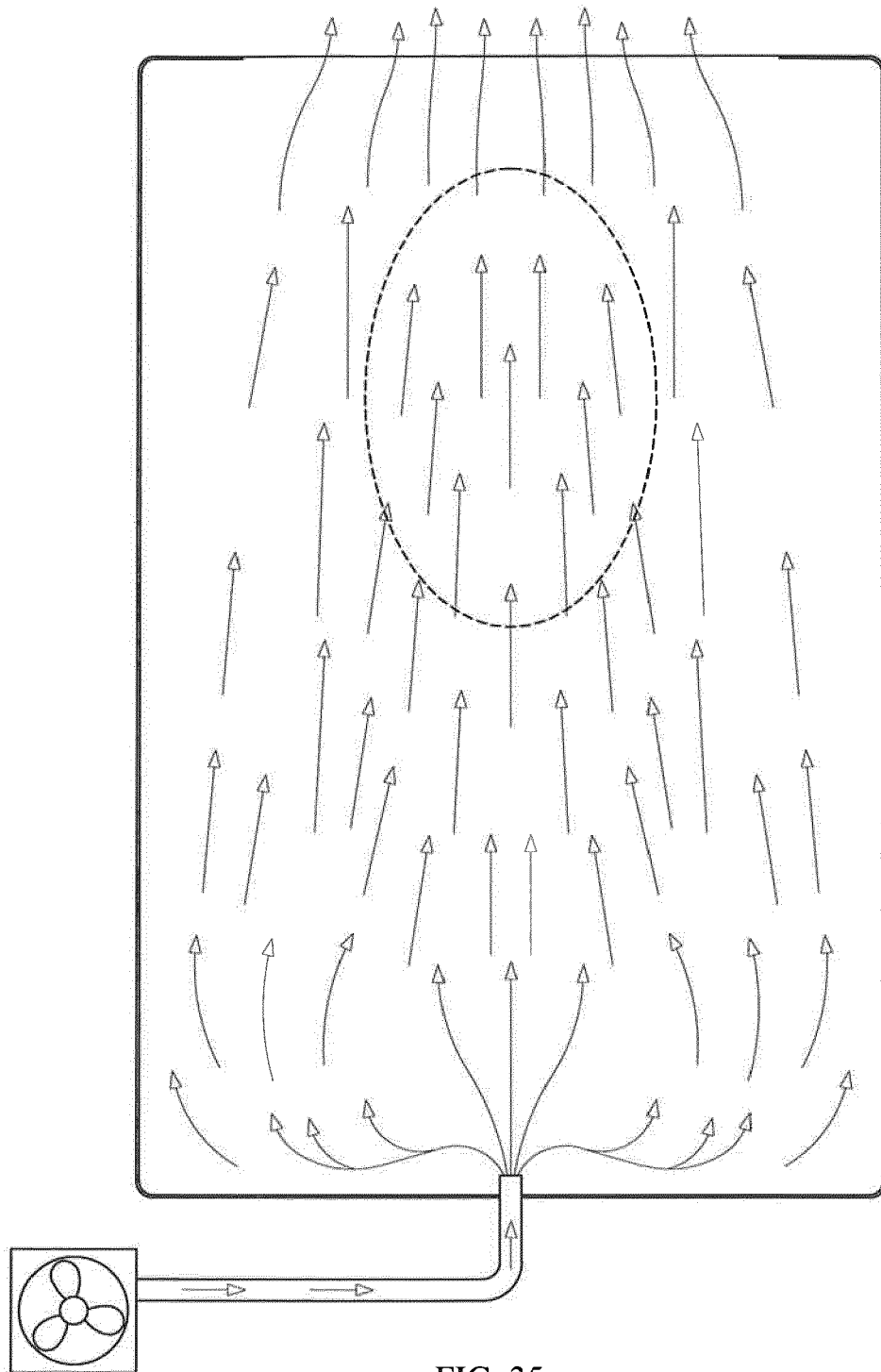
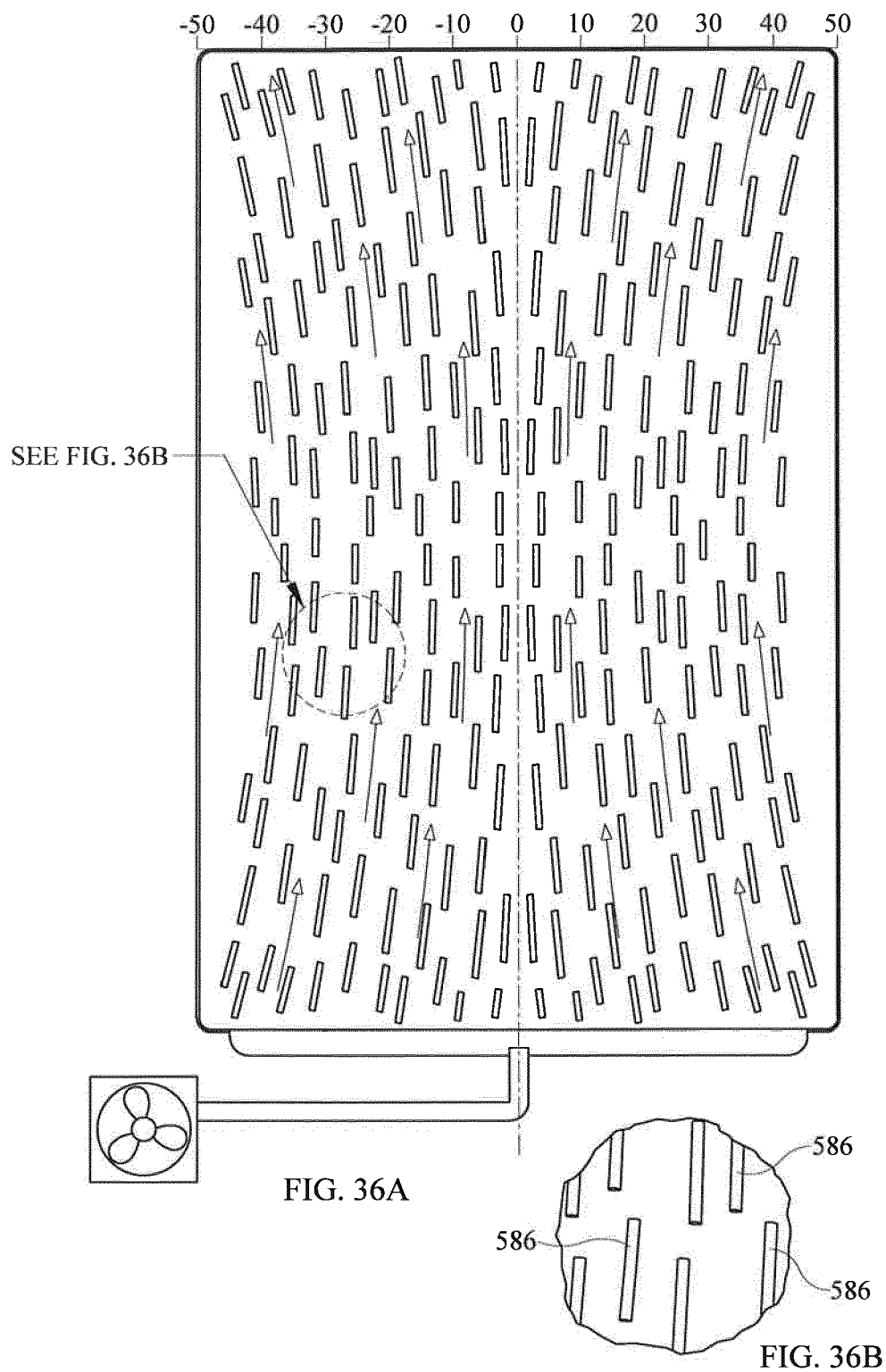


FIG. 35



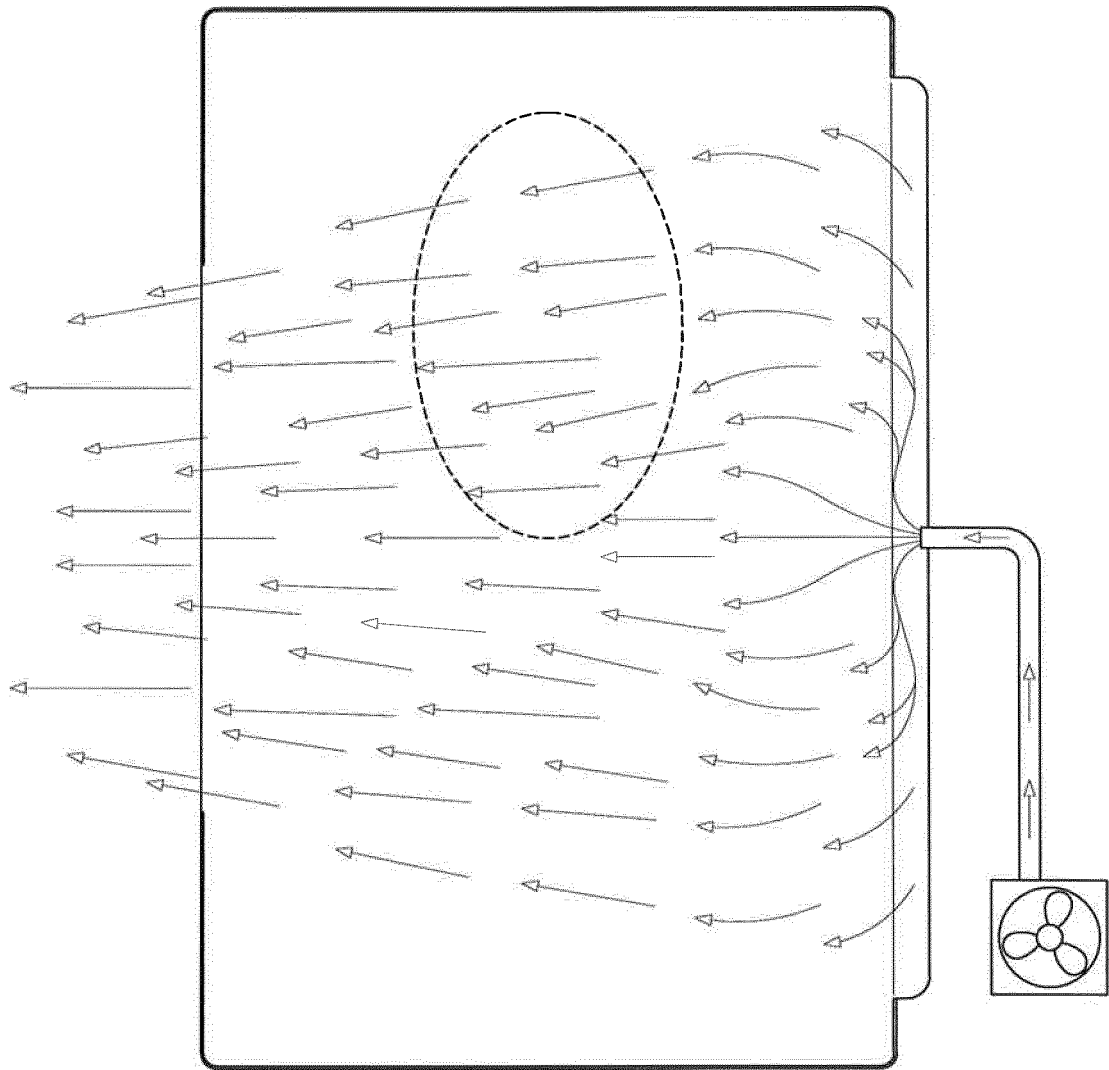


FIG. 37

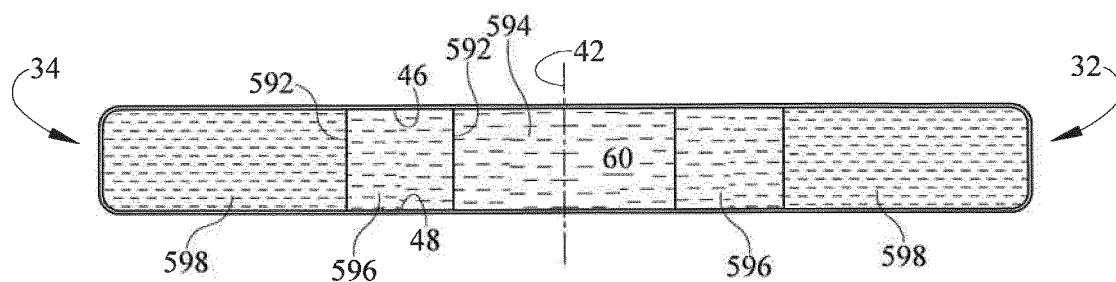


FIG. 38

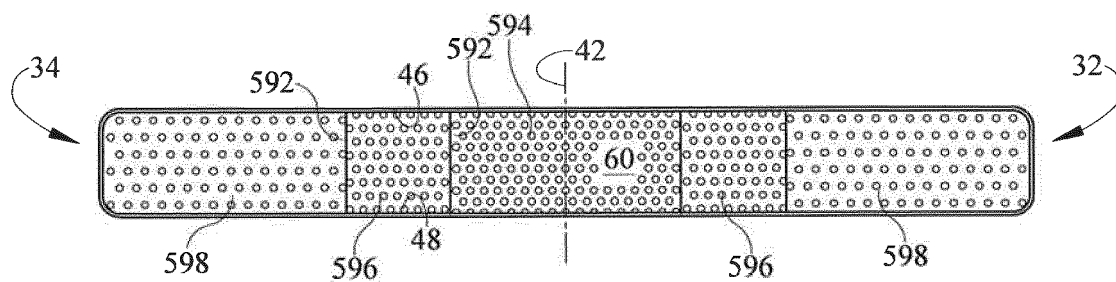


FIG. 39

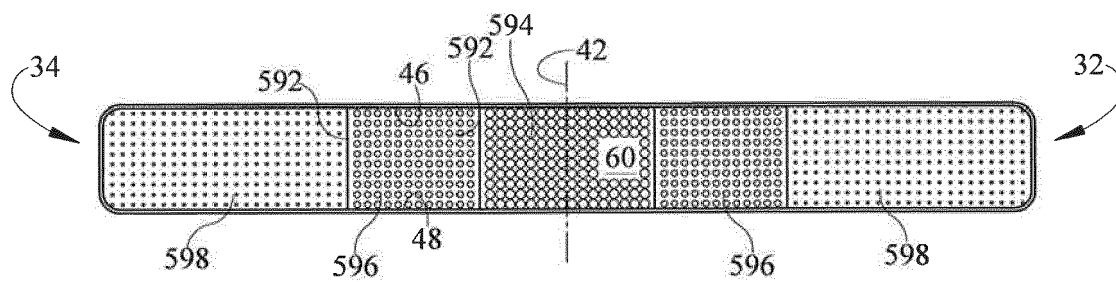


FIG. 40

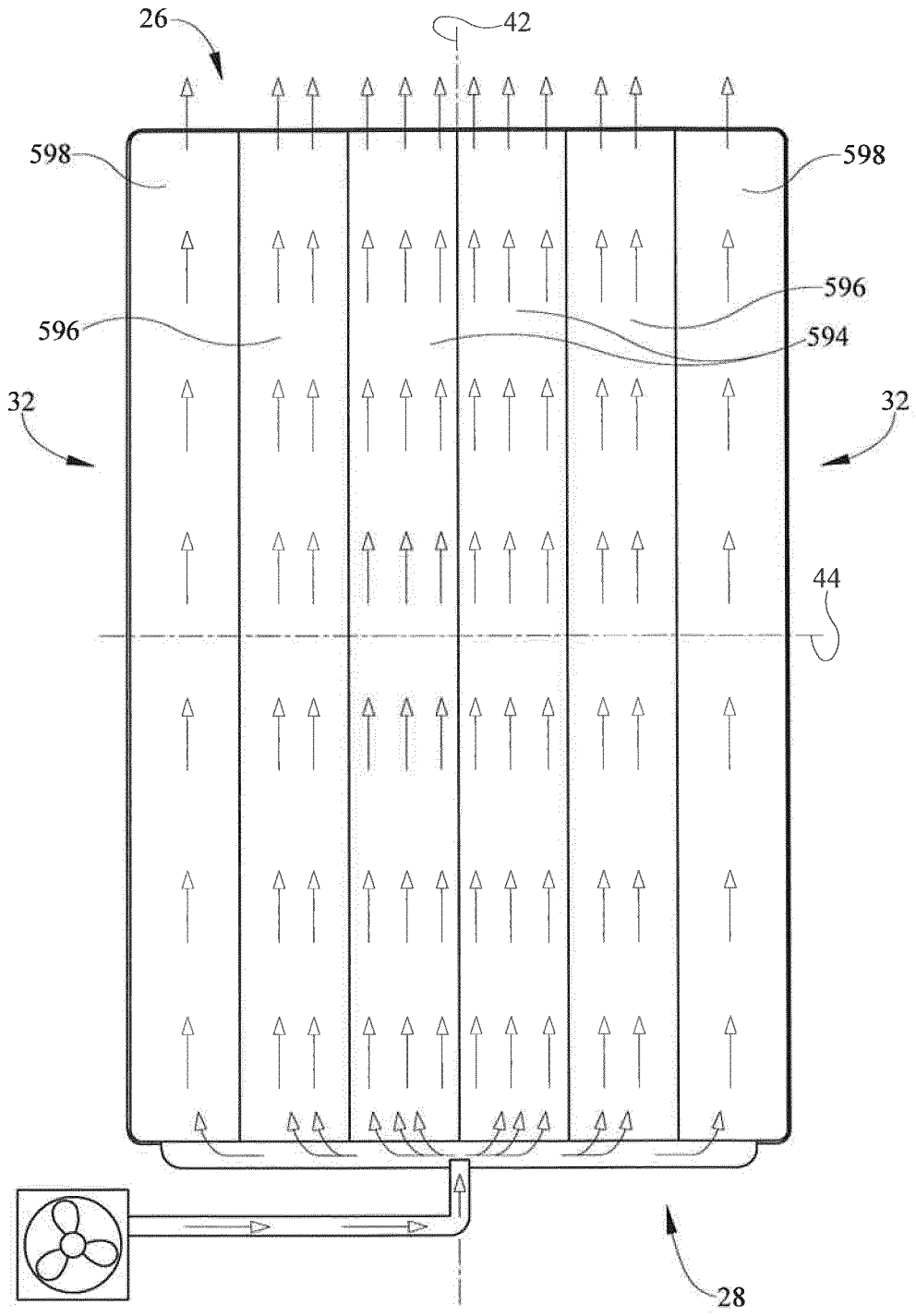


FIG. 41

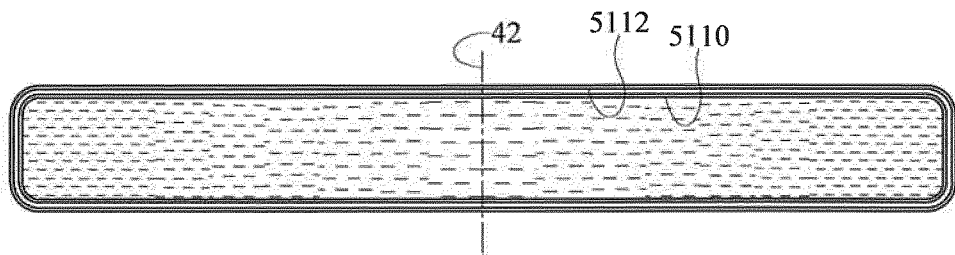


FIG. 42

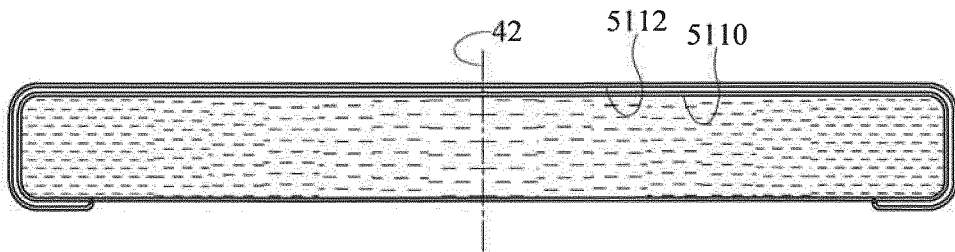


FIG. 43



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Application Number
EP 14 18 1760

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A	WO 2011/026040 A1 (AMERIGON INC [US]; BRYKALSKI MICHAEL J [US]; MARQUETTE DAVID [US]; TER) 3 March 2011 (2011-03-03) * abstract; figures *	1-15	
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A	US 2007/261548 A1 (VRZALIK JOHN H [US] ET AL) 15 November 2007 (2007-11-15) * abstract; figures *	1-15	
			TECHNICAL FIELDS SEARCHED (IPC)
			A61G A47C
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 16 October 2014	Examiner MacCormick, Duncan
CATEGORY OF CITED DOCUMENTS			
X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document			
T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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