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(54) FAN SHROUD FOR HEAT EXCHANGE TOWER FANS

LÜFTERHAUBE FÜR WÄRMETAUSCHERTURMVENTILATOREN

CAPOT DE REFOULEMENT DE VENTILATEUR POUR VENTILATEURS DE COLONNE
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Description

FIELD OF THE INVENTION

[0001] The invention relates to the field of heat exchange towers, and more particularly relates to the field of fans used to move air through heat exchange towers, including industrial cooling towers, industrial heating towers, and air cooled steam condensers.

BACKGROUND OF THE INVENTION

[0002] A wide variety of heat exchange towers are known in the industry. These heat exchange towers include, for example, so-called industrial cooling towers, which are used to cool warm water by industrial or other processes. These cooling towers typically have a liquid that is sprayed from a top inside the tower, and falls over a media such as, for example, splash bars or a pack of spaced apart thin film sheets. Air is typically drawn through the tower, either sideways across the tower, upwardly through the tower, or a combination thereof, and interacts with the falling liquid. The falling liquid is warmer than the ambient air, and thus is cooled by this process and falls into a collection basin at the bottom of the tower. Another type of heat exchange tower is a heating tower which may be used, for example, for the vaporization of liquefied natural gas.

[0003] Yet another type of tower is an air cooled condenser (ACC) tower. Such a tower is typically a large box-like structure having an open lower or side frame. The open frame may be closed off on some of its sides. The frame supports a deck having a series of fans which blow air upward so that the air is drawn in through the open sides of the tower and is forced upward by the fans. Above the fans the tower supports a series of condenser coils. In some examples, a plurality of steam supply header tubes run lengthwise on the top of the tower and disperse steam downward into angled downwardly extending condenser coils. Water is heated in a boiler to create steam, which is then sent to a high pressure end of a turbine to create work (via change in energy of the steam). The steam at the low pressure end of the turbine then is condensed by the condenser to create a vacuum that pulls the steam through the turbine. At the bottom of the angled downwardly extending condenser coils is a series of collection header tubes which receives condensed fluid and exits it from the tower. The entirety of the condenser coils is usually located above the fans. Air is exhausted out the open top of the tower past the steam supply header tubes. A deck of the fans is added below the coils to provide a greater volume of air flow. The deck typically has a number of fans spaced in a grid-like arrangement, each surrounded by a fan shroud. Other terms for fan shroud are fan inlet bell or fan casing. An example of a different ACC tower is described in U.S. Patent Publication No. 2006/0243430.

[0004] All of the above types of towers are suitable for

various applications and have found wide acceptance in industry. However, it is often desirable in such tower installations to reduce the noise or sound that is produced by the tower. One major cause of noise or sound in some towers is noise that is generated by the operation of the fans themselves. In the case of ACCs, a relatively large number of fans is often present, and thus the desire to reduce the noise associated with each fan is sometimes even greater than with other types of heat exchange towers.

[0005] US4508486 discloses a high-speed, high-volume ventilation fan, with a noise-attenuating housing structure including a perforated inner casing contained within a solid-walled outer casing. Filling the space between the inner and outer casings is a porous, sound-absorbing material. To prevent loss of downstream pressure, and therefore operational efficiency, due to leakages of air through the sound-absorbing material from the downstream side at the fan blades to the upstream side thereof, an annular anti-flow barrier is situated in the space between the inner and outer casings slightly downstream of the fan blades. The structure thus provides a high degree of noise attenuation without sacrificing operational efficiency.

[0006] US2002015640 discloses a porous damping material attached to an entire inner circumference of the fan shroud opposing to an end of a fan and is exposed to opposing space without using conventional perforated metal. Accordingly, jet noise caused by strong swirl between the fan and the fan shroud can be damped by the damping material and impulsive sound scarcely occurs. Thus, both of the impulsive sound and the jet noise can be effectively damped, thereby securely reducing noise. The porous member constituting the porous damping material is a die-molding product made by a die having a cavity.

SUMMARY OF THE INVENTION

[0007] The invention provides a heat exchange tower comprising at least one fan having fan blades with outer tips rotating in a circle of rotation and a fan shroud, the fan shroud comprising an outer ring structure wherein a sound absorbing material is mounted to the outer ring structure and disposed radially inside the outer ring structure and outside of the circle of rotation of the tips of the fan blades. The outer ring structure is formed of at least one section including at least two axially spaced pockets separated by a rib in between the pockets, with sound absorbing material disposed in each pocket.

[0008] The invention is defined by the independent claim. The dependent claims define preferred embodiments.

[0009] In this respect, before explaining at least one embodiment of the invention in detail, it is to be understood that the invention is not limited in its application to the details of construction and to the arrangements of the components set forth in the following description or

illustrated in the drawings. The invention is capable of embodiments in addition to those described and of being practiced and carried out in various ways. Also, it is to be understood that the phraseology and terminology employed herein, as well as the abstract, are for the purpose of description and should not be regarded as limiting.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010]

FIG. 1 is a schematic perspective view of an air cooled condenser having a fan deck with a plurality of fan shrouds.

FIGS. 2-6 show an example air-cooled condensing unit which is not part of the invention.

FIG. 2 is a bottom view of a fan surrounded by a fan shroud.

FIG. 3 is a sectional view of a fan and a fan shroud taken through line 3-3 in FIG. 2.

FIG. 4 is a detailed view of a fan shroud taken through the detail circle of FIG. 3.

FIG. 5 is a slightly cutaway perspective view of the fan shroud.

FIG. 6 is a cutaway perspective view of the fan shroud shown in FIG. 5.

FIG. 7 is a somewhat exploded view of a fan shroud according to the invention.

FIG. 8 is a cutaway detail view of the fan shroud of FIG. 7.

DETAILED DESCRIPTION

[0011] Some heat exchange tower fans have a fan shroud for including a noise reducing material that can reduce fan noise coming from the heat exchange tower. In some examples, the fan shroud includes an outer ring structure and the sound absorbing material is disposed inside the outer ring structure and outside the circle of rotation of the tips of the fan blades. Some examples will now be described with reference to the drawing figures, in which like reference numerals refer to like parts throughout.

[0012] Turning now to FIG. 1, an air cooled condensing (ACC) tower 10 is shown. The tower includes a base 12 which rests on the ground and lower framework 14 which supports a fan deck 16. The lower framework 14 is shown simply as being legs at the corner of the tower. However, it will be appreciated by one skilled in the art that such a frame 14 is typically an internal lattice framework having

columns and girts interconnected with each other to form an open frame. All four sides of the frame may be left open below the fan deck 16, or in some instances two of the opposed sides may each have a closed wall. Examples of an ACC illustrated herein will be described in the context of having the two end walls labeled 18 and 19 as being closed and the two sides labeled 20 and 21 as being open. However, it will be appreciated may have any number of open or closed sides beneath the fan deck 16.

[0013] The fan deck 16 is a support structure which typically supports a plurality of individual fans 24 (blades not shown in FIG. 1 for clarity of illustration), each having their own fan shroud 26 associated therewith. The fan shrouds 26 are discussed in further detail below. The fans 24 blow air upward past a series of angled condenser tube coil structures 28. The coils 28 are elongated coils generally forming a planar sheet-like structure which air can pass through. The coils 28 receive steam from a plurality of steam supply headers 30. The steam supply headers lead into the coils 28 and steam/water falls downward vertically through the coils 28 and is cooled by heat exchange with the ambient air outside the coils 28. The steam condenses into water which is collected in lower water collection headers 32 and discharged from the tower.

[0014] An upper frame structure 40 is typically provided to provide overall structural support to the area having the supply headers 30, condenser coils 28, and water headers 32. The coil and header pieces build into an upper superstructure. The frame structure 40 is simply framing for the casing. The casing may extend to approximately the bottom of the steam header or may extend some modest distance above the steam header. This upper frame 40 typically will have all four sides closed by solid or generally non-porous side walls or coverings 42 on all four sides. It will be appreciated that in FIG. 1 many solid items such as the side walls are shown being transparent so that an inner view of the tower 10 can be provided.

[0015] FIGS. 2-6 show an example air-cooled condensing unit which is not part of the invention. In this example, the fan shroud 26 includes an eased or flared, inwardly tapered inlet section 102, as well as a noise absorbing section 104, which is disposed at the axial position of the fans, and surrounds the fan tips as they rotate.

[0016] The noise absorbing section 104 is adapted to reduce sound coming from the fan tips in particular, and the fan in general. The eased or flared inlet section 102 may be of a relatively conventional construction and can be, for example, made of segments of molded fiberglass material, or may be in sections or a continuous piece of rolled steel. The noise absorbing section 104 includes as some portion thereof a sound absorbing material 114. Various arrangements for mounting the sound absorbing material 114 are discussed further herein. Sound absorbing materials may comprise any known or future discov-

ered sound absorbing material, such as, for example, fiberglass batting or foam. Also, the sound absorbing material may comprise an irregular shaped surface material. By way of example, only some suitable materials include acoustical foam such as that made by SONEX®, or open and closed all flexible polyurethane, polyimide, melamine and other absorption foams, or flexible external viscoelastic and constrained layer products available from SOUNDCOAT®. Simple fiberglass batting such as used for insulation is also suitable. Also, besides the above and other passive materials, locally active materials may be employed. Combinations of different sound absorbing materials may also be used. Further, the sound absorbing material may span entirely around the circumference of the noise absorbing portion 104, may span across arcuate portions of the noise absorbing portion 104, and may span either part of the entire height of the noise absorbing portion 104. Further, although the noise absorbing portion 104 is referred to herein for convenience as having a straight side, it may of course also have either or both of its inner and outer surfaces being a somewhat convex, or somewhat concave shape, or may have an undulating shape. Further, the noise absorbing portion 104 may simply be a truncated cone flaring in either the upwards or downwards direction, or a combination of outward and upward flaring cones.

[0017] Turning now particularly to FIGS. 4 and 5, the noise absorbing section 104 is illustrated as further having an outer ring 106, which has a straight C-shaped cross section and may be formed by a rolled steel cylinder having a straight sided outer wall 108 and top and bottom walls 110 and 112. The arrangement also features a thickness of sound absorbing material 114, which in one example may be fiberglass batting. As discussed herein, the sound absorbing material 114 may be other materials such as foam or a material having a complex reflective or absorbing surface finish. Also, combinations of various sound absorbing materials may be used to make up the sound absorbing material 114.

[0018] In the illustrated example, an inner screen 120 is provided inside of the location of the sound absorbing material 114. The screen 120 is at least somewhat permeable to sound so that the sound will be absorbed by the sound absorbing material 114, and further can provide structural support to retain the sound absorbing material 114 in place. In this example, a steel screen is used having 20 to 50 per cent open area. Examples of suitable screens include metal or plastic plate perforated with holes or slots, or metal or plastic mesh. In the case of a sound absorbing material 114 that loses its integrity when subjected to airflow, vibration and/or moisture, the screen 120 serves the function of retaining the sound absorbing material 114 in its place, so that it does not tend to shred or come apart. The screen 120 also reduces the moisture that will enter the sound absorbing material 114 in the case of, for example, rain falling into the fan shroud. Additionally, a water resistant membrane may be placed between screen 120 and sound absorbing material 114.

A water resistant membrane example is Gore-Tex® material. In the example as depicted in FIGS. 3-5, the overall fan shroud 26, including the sound absorbing material features, is supported from above by a fan deck 16 by using conventional support arrangement.

[0019] FIG. 6 shows the outer ring 106 in combination with the screen 120 forming a hollow pocket 122. In FIG. 6 the sound-absorbing material 114 is not shown. FIG. 6 also shows that the outer ring 106 can be made of a number of rolled boxed curved steel segments, which can be joined by virtue of flanges 124 that accept bolts into neighboring flanges of the neighboring arcuate sections. FIG. 6 also illustrates a flange 126 provided along the bottom of the ring 106, which can facilitate joining with the flared inlet portion 102.

[0020] FIGS. 7 and 8 illustrate an exemplary embodiment of a fan shroud according to the invention which utilizes the principles of the example described above, but adds some variations and additional features. For example, in the embodiment of FIG. 7, a flared inlet section 202 is integral with the outer ring of the noise absorbing section 204. Thus, an entire shroud is formed by a plurality of arcuate sections with each section having a lower flared portion 204 and an upper outer ring of a sound absorbing portion 204. In the exemplary embodiment of FIG. 7, the entire shroud is made of a plurality of arcuate sections. In this exemplary embodiment, each arcuate section has been molded from fiberglass material. Joining flanges 224 are provided, and can be bolted to each other. In the case of fiberglass construction, intermediate steel plates re-enforcements may be bolted to be sandwiched in between the neighboring flanges 224.

[0021] Turning further to the sound absorbing portions 204 in the embodiment of FIGS. 7 and 8, each section forms part of the sound absorbing portion 204 and has one or more pockets 222 that are molded directly into the structure. In particular, two elongated pockets 222 are molded one above the other. This provides an intermediate rib structure 223 between the pockets 222 which can enhance the stiffness of the sections.

[0022] As with the previous example discussed above, a screen 220 is provided forming part of the inner surface of the fan shroud. Disposed between the screen 220 and the pockets 222 are sound absorbing material 214. As illustrated in FIG. 7, the sound absorbing material 214 includes segments of fiberglass batting 208. The fiberglass batting 208 tends to absorb sound. Although fiberglass batting is discussed with respect to this embodiment, any other sound absorbing material or a combination of materials may be employed. In the embodiment of FIGS. 7 and 8, the screen may be attached by screws 232 screwed into the ring structure 204.

[0023] The above-described examples and embodiment show structures that can reduce the sound emitted by a fan deck in an ACC. Aspects of these examples and embodiment can also be applied to other heat exchange tower fans.

Claims

1. A heat exchange tower (10), comprising at least one fan (24) having fan blades with outer tips rotating in a circle of rotation and a fan shroud (26), the fan shroud (26) comprising an outer ring structure (204) wherein a sound absorbing material (214) is mounted to the outer ring structure and disposed radially inside the outer ring structure (204) and outside of the circle of rotation of the tips of the fan blades, wherein the outer ring structure (204) is formed of at least one molded section including at least two axially spaced pockets (222) separated by a rib (223) in between the pockets (222), with sound absorbing material (214) disposed in each pocket (222).
2. The heat exchange tower of claim 1, **characterized in that** the fan shroud (26) comprises a flared inlet portion (202) leading into the outer ring structure (204).
3. The heat exchange tower of claim 2, **characterized in that** the inlet portion (202) is integral with the outer ring structure (204).
4. The heat exchange tower according to claim 1, **characterized in that** it further comprises an inner supporting means (220) that sandwiches the sound absorbing material (214) between the inner supporting means and the outer ring structure (204).
5. The heat exchange tower according to claim 1, **characterized in that** the outer ring structure (204) comprises a plurality of arcuate sections.
6. The heat exchange tower according to any of previous claims, **characterized in that** the sound absorbing material (214) is fiberglass batting (208) or foam.

Patentansprüche

1. Wärmetauscharturm (10), umfassend wenigstens ein Gebläse (24) mit Gebläseschaufeln mit äußeren Spitzen, die in einem Rotationskreis rotieren, und einen Gebläsekragen (26), wobei der Gebläsekragen (26) eine äußere Ringstruktur (204) umfasst, wobei ein schalldämmendes Material (214) an der äußeren Ringstruktur befestigt und radial innerhalb der äußeren Ringstruktur (204) und außerhalb des Rotationskreises der Spitzen der Gebläseschaufeln angeordnet ist, wobei die äußere Ringstruktur (204) aus wenigstens einem abgeformten Abschnitt geformt ist, die wenigstens zwei axial beabstandete Taschen (222) einschließen, die durch eine Rippung (223) zwischen den Taschen (222) getrennt sind, wobei in jeder Tasche (222) schalldämmendes Material (214) angeordnet ist.

2. Wärmetauscharturm gemäß Anspruch 1, **dadurch gekennzeichnet, dass** der Gebläsekragen (26) einen aufgerandeten Einlassabschnitt (202) umfasst, der in die äußere Ringstruktur (204) führt.
3. Wärmetauscharturm gemäß Anspruch 2, **dadurch gekennzeichnet, dass** der Einlassabschnitt (202) mit der äußeren Ringstruktur (204) ein Stück bildet.
4. Wärmetauscharturm gemäß Anspruch 1, **dadurch gekennzeichnet, dass** er weiterhin ein inneres Stützmittel (220) umfasst, das das schalldämmende Material (214) zwischen dem inneren Stützmittel und der äußeren Ringstruktur (204) einklemmt.
5. Wärmetauscharturm gemäß Anspruch 1, **dadurch gekennzeichnet, dass** die äußere Ringstruktur (204) eine Vielzahl von bogenförmigen Abschnitten umfasst.
6. Wärmetauscharturm gemäß irgendeinem der voranstehenden Ansprüche, **dadurch gekennzeichnet, dass** das schalldämmende Material (214) Glasfaserwatte (208) oder Schaumstoff ist.

Revendications

1. Colonne d'échange thermique (10), comprenant au moins un ventilateur (24) comportant des pales de ventilateur présentant des pointes extérieures tournant en un cercle de rotation, et un capot de ventilateur (26), le capot de ventilateur (26) comprenant une structure annulaire extérieure (204), dans laquelle un matériau d'absorption de son (214) est monté sur la structure annulaire extérieure et est disposé radialement à l'intérieur de la structure annulaire extérieure (204) et à l'extérieur du cercle de rotation des pointes des pales de ventilateur, dans laquelle la structure annulaire extérieure (204) est constituée d'au moins une section moulée comportant au moins deux poches axialement espacées (222) séparées par une nervure (223) entre les poches (222), avec un matériau d'absorption de son (214) disposé dans chaque poche (222).
2. Colonne d'échange thermique selon la revendication 1, **caractérisée en ce que** le capot de ventilateur (26) comprend une partie d'entrée évasée (202) qui conduit dans la structure annulaire extérieure (204).
3. Colonne d'échange thermique selon la revendication 2, **caractérisée en ce que** la partie d'entrée (202) est intégrée avec la structure annulaire extérieure (204).
4. Colonne d'échange thermique selon la revendication 1, **caractérisée en ce qu'elle** comprend en

outre des moyens de support intérieurs (220) qui coïncident le matériau d'absorption de son (214) entre les moyens de support intérieurs et la structure annulaire extérieure (204).

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5. Colonne d'échange thermique selon la revendication 1, **caractérisée en ce que** la structure annulaire extérieure (204) comprend une pluralité de sections courbes.

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6. Colonne d'échange thermique selon l'une quelconque des revendications précédentes, **caractérisée en ce que** le matériau d'absorption de son (214) est une ouate de fibre de verre (208) ou une mousse.

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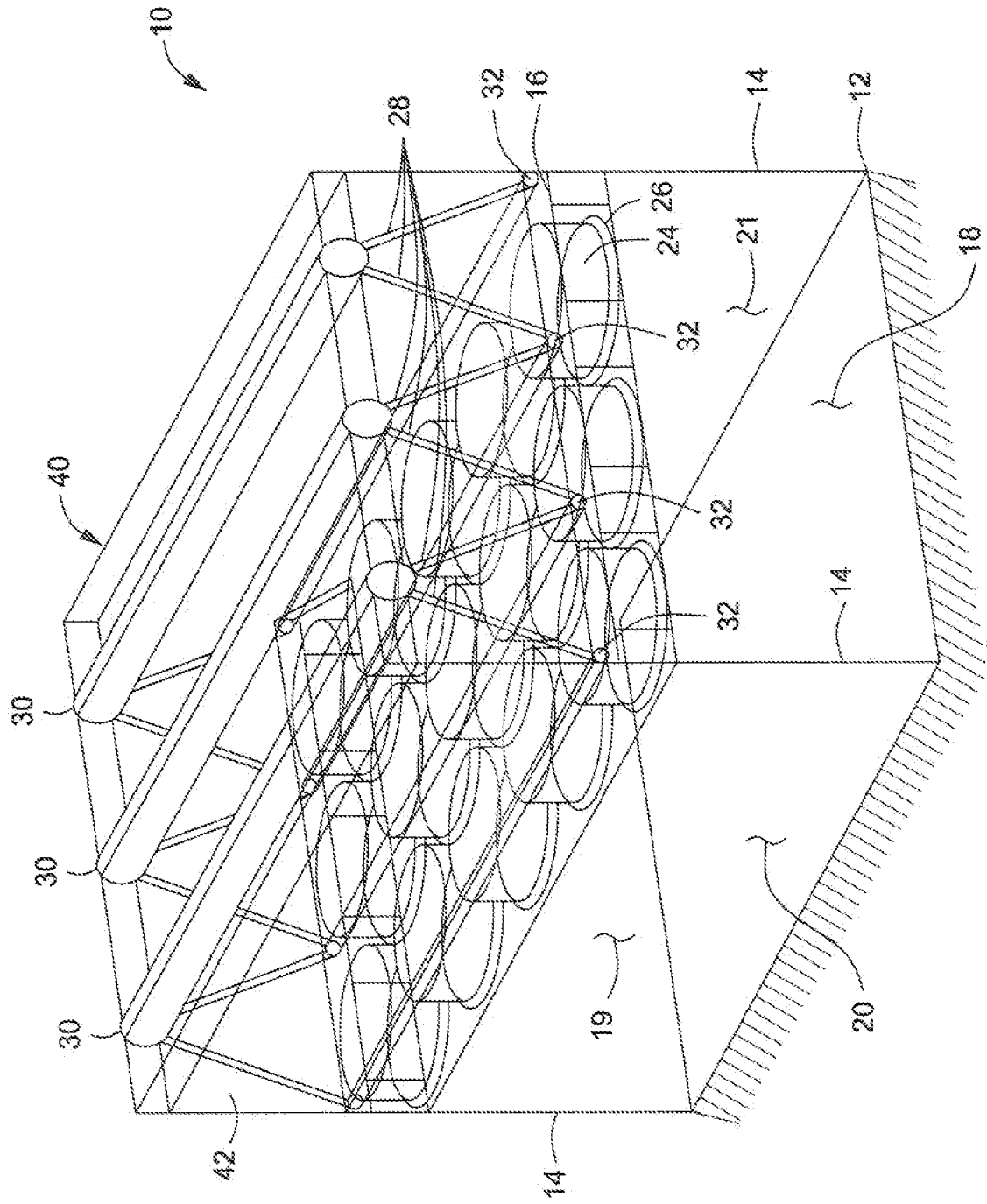
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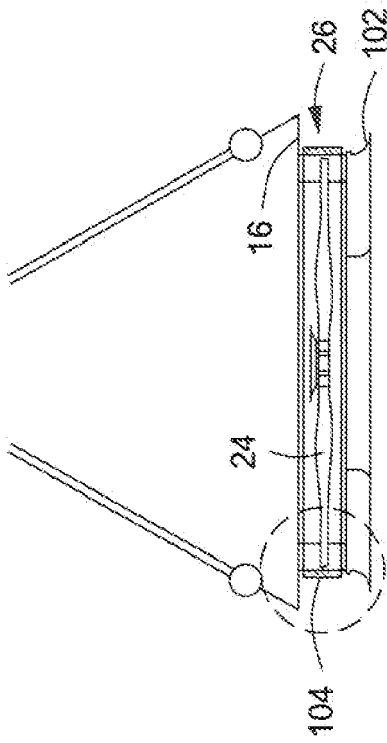


FIG. 3

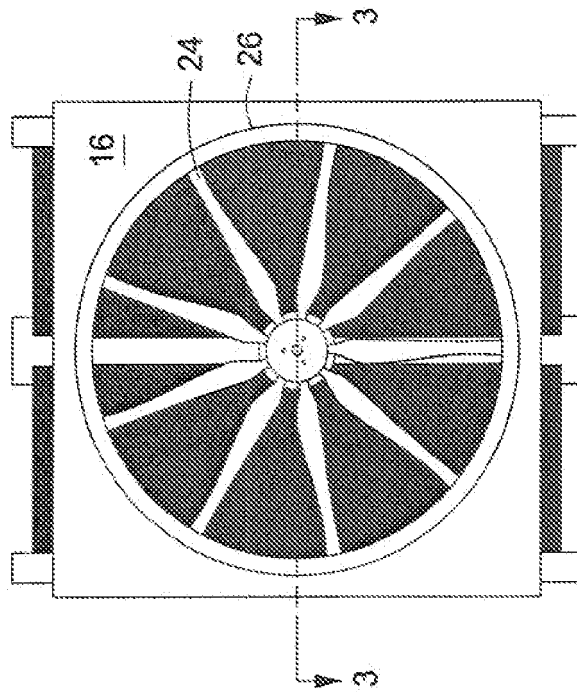


FIG. 2

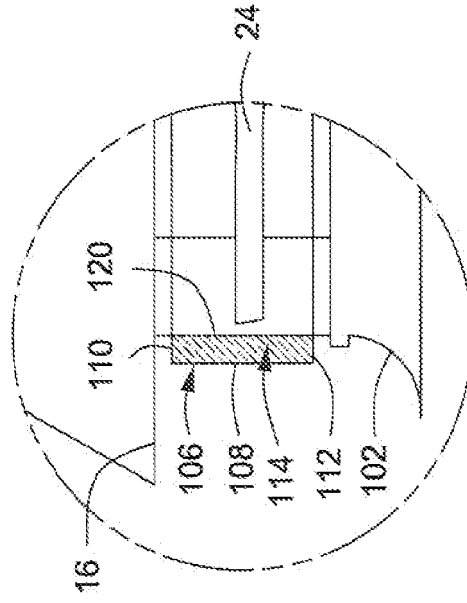


FIG. 4

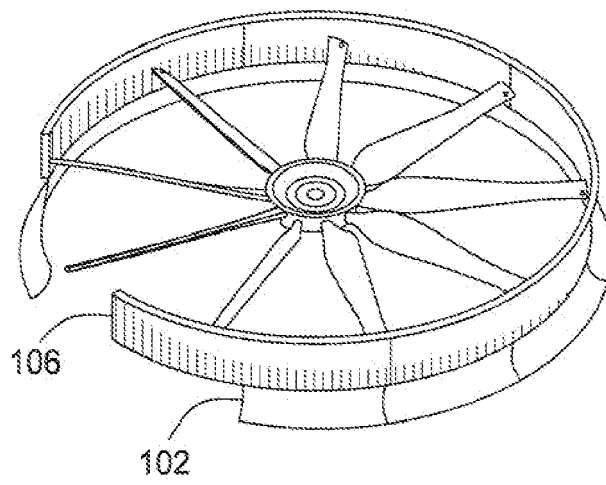


FIG. 5

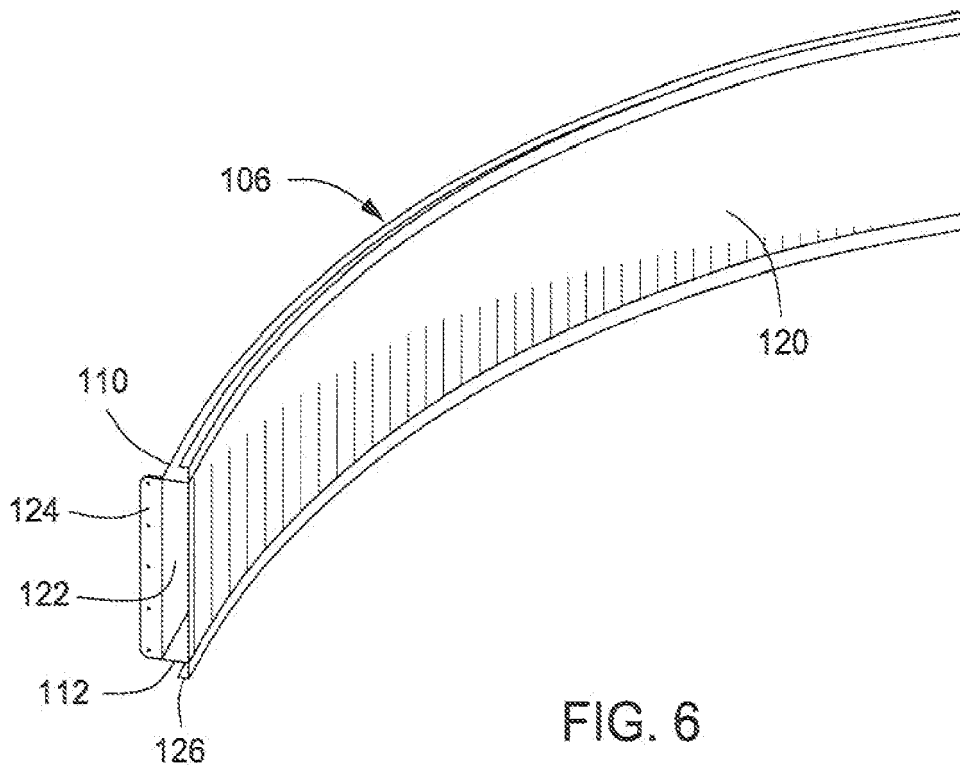


FIG. 6

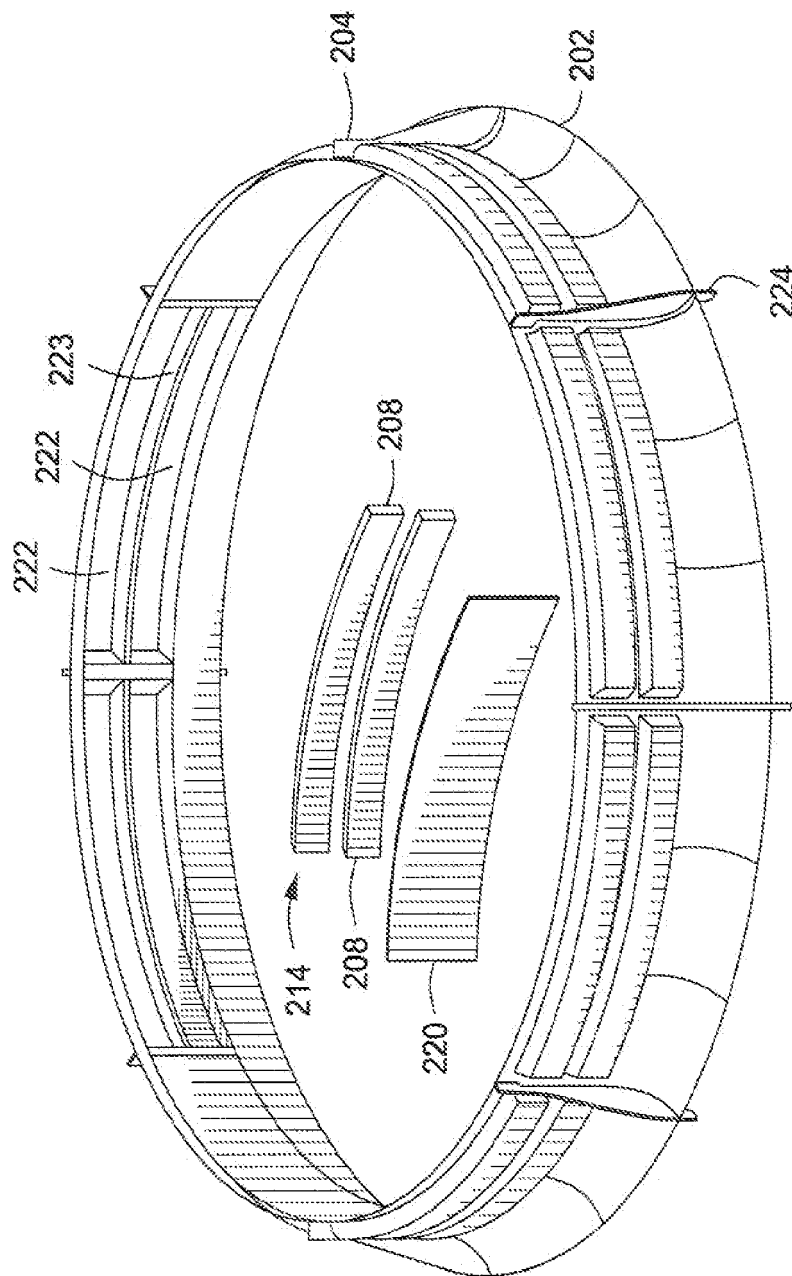


FIG. 7

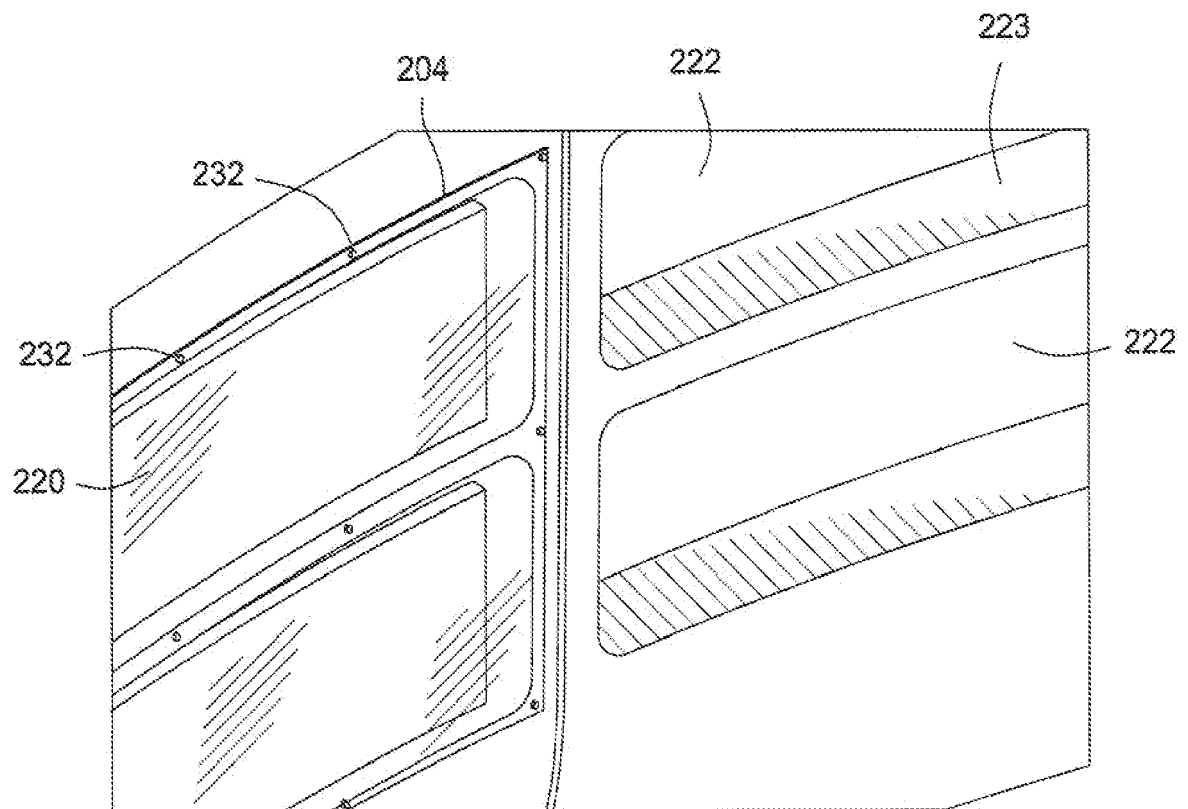


FIG. 8

REFERENCES CITED IN THE DESCRIPTION

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