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(54) **COOLING TOWER SPLASH FILL**

(57) A splash fill arrangement for use in a direct heat exchange section of a cooling tower is provided. Each splash fill arrangement includes support plates and elongated bars extending there between, which arrangement improves the performance of the splash fill arrangement

when installed as a direct heat exchange section of a cooling tower. Certain of the elongated bars between the support plates are angled from the horizontal to improve the air flow capabilities and performance of the direct heat exchange section.

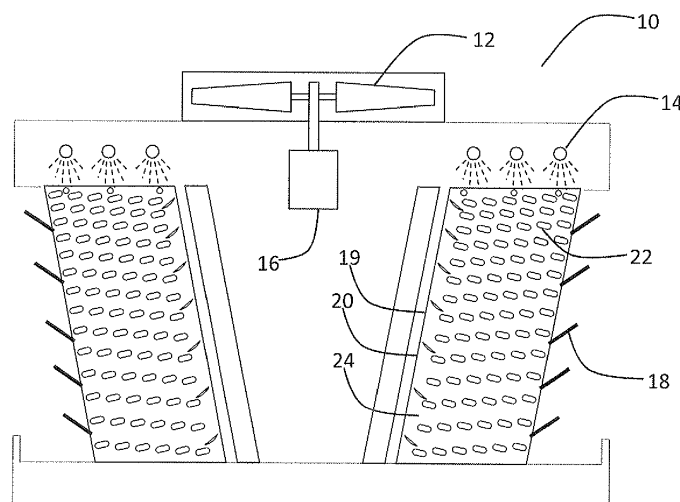


FIG. 1

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Description

Background of the Invention

[0001] The present invention relates to a heat and mass transfer media, or a splash fill arrangement, utilized within the direct heat exchange portion of a cooling tower. More particularly, the present invention relates to a splash fill arrangement for use in a direct heat exchange unit, which could be a cooling tower.

[0002] The heat and mass transfer media, or splash fill arrangement, is generally horizontally oriented with an evaporative liquid, usually water, coursing over the arrangement, usually flowing downwardly, with an air stream directed usually transversely but potentially concurrent or cross current through the splash fill arrangement comprising a direct cooling section. The air interacts with the evaporative liquid for heat and mass transfer.

Summary of the Invention

[0003] The heat and mass transfer media, or splash fill arrangement, of the present invention enhances the thermal efficiency of the direct heat exchanger by providing an arrangement of splash fill components over which air and an evaporative liquid, usually water, pass. The arrangement of splash fill components is comprised of two or more support plates, between which a plurality of elongated bars extend. The elongated bars are positioned at predetermined locations and angles to provide an improved direct heat exchanger. The improved performance of the direct heat exchanger is related to the shape, positioning and angle placement of the elongated bars. By placing the elongated bars of the various preferred shapes at such preferred locations and angles, improved flow of the evaporative liquid, usually water, over the elongated bars occurs. Improved flow of the evaporative liquid includes improved drop formation and flow direction when the evaporative liquid drops leave the elongated bars. Such improved drop formation is combined with improved air flow between and across the elongated bars. This combination of improved drop formation and improved air flow leads to improved heat transfer in the direct heat exchanger.

[0004] When the evaporative liquid passes generally downwardly over the elongated bars of the splash fill arrangement, portions of the evaporative liquid spills from certain of the elongated bars, wraps around certain of the elongated bars and then falls from the bars or both. The cooling air which is usually drawn across the elongated bars by a fan causes some of the evaporative liquid to evaporate and thusly result in mass and heat transfer.

[0005] The cross sectional shape of the splash fill component elongated bar can be of various types, but usually includes rounded corners to allow the evaporative liquid to both flow across portions of and in some embodiments wrap around the cross section of the elongated bar. Such flow improves the heat transfer from the evaporative liq-

uid and the air passing through the splash fill arrangement.

[0006] The splash fill elongated bars are usually angled downwardly from 5 to 45 degrees from the horizontal toward the air inlet side of the splash fill arrangement. This angled orientation of the elongated bars assists in exposing more of the evaporative liquid flowing across the bars to the air moving across the splash fill arrangement, without unduly impeding the air flow. In certain embodiments of the splash fill arrangement of the present invention, most arrays of elongated bars will be angled downwardly from 5 to 45 degrees from the horizontal, while an intermittent array of elongated bars will not be so angled, but rather be at a horizontal orientation.

Brief Description of the Drawings

[0007] In the drawings,

FIG. 1 is a side cross sectional view of a splash fill arrangement in a cooling tower in accordance with a first embodiment of the present invention;
FIG. 2 is a detailed perspective side view of a portion of a splash fill arrangement in accordance with a first embodiment of the present invention;
FIG. 3 is a schematic cross sectional view of a splash fill arrangement in accordance with a second embodiment of the present invention;
FIG. 4 is a schematic cross sectional view of a splash fill arrangement in accordance with a third embodiment of the present invention, and
FIG. 5 includes schematic views of cross sections of elongated bars of a splash fill arrangement in accordance with three embodiments of the present invention.

Description of the Preferred Embodiment

[0008] Referring now to FIG.1 of the drawings, a cooling tower is shown at 10. Cooling tower 10 includes motor 16 which drives fan 12. Fan 12 causes an air flow inwardly from the sides of cooling tower 10 and accordingly across inlet louvers 18 and exiting upwardly out through the cowl around fan 12. Other air flow directions and fan arrangements such as coaxial side draw fans that result in air flow across or across and upwardly through splash fill arrangement 20 are part of the present invention. Cooling tower 10 is a direct heat exchanger, as an evaporative liquid, usually water, flows downwardly from water spray nozzles or openings 14. Such nozzles or openings are placed in a water distribution line. Splash fill arrangement 20 is seen to comprise a generally rectangular support plate 24. Support plate 24 can be comprised of structural plastic such as PVC, or aluminum or galvanized steel or stainless steel. Support plate 24 includes a plurality of openings to receive and support elongated bars 22. Although only a single support plate is shown and described, it should be understood that two or more support

plates would usually be utilized in a cooling tower splash fill arrangement. The openings in support plate 24 are sized to correspond to the cross section of elongated bars 22 to appropriately support elongated bars in cooling tower 10. Elongated bars 22 themselves may be comprised of structural plastic such as PVC, or aluminum or galvanized steel or stainless steel. Support plate 24 is shown to be of a generally rectangular and generally planar structure; however, it should be understood that based on design of installation needs support plate 24 may be of a square or trapezoidal structure as well. When installed splash fill arrangement 20 is installed in a direct heat exchange unit, usually as a component of a cooling tower, an evaporative liquid, usually water, flows downwardly onto a top portion of splash fill arrangement 20 and exits from a bottom portion thereof. Inlet louvers 18 help prevent water from exiting cooling tower 10 in a sideways direction without passing through the entire splash fill arrangement 20. First side edge of cooling tower 10 with inlet louvers 18 is typically an air inlet edge wherein air is forced or drawn cross-current to the evaporative liquid downward flow to exit from second side edge 19. Such combination of evaporative liquid down flow and cross-current air flow acts to remove heat from the evaporative liquid by both a heat and mass transfer operation. It should be understood that air flow may be somewhat counter current or con-concurrent with the evaporative liquid downward flow, depending on the design of the direct heat exchange unit and the fan placement.

[0009] Referring now to FIG. 2, a first embodiment of a splash fill arrangement is shown as comprising support plate 30 and elongated bars 32. The composition of support plate 30 and elongated bars 32 are as set forth above. However, elongated bars 32 are shown to be installed in support plate 30 at an angle to the horizontal. Such angle is preferably between 5 and 45 degrees. Such angled installation of elongated bars 32 is designed to improve the heat exchanging performance of the direct heat exchange system into which the splash fill arrangement is installed. Air flow is depicted as from left to right in Fig. 2 as shown by the arrow. Water flow is generally downward. This angled orientation of elongated bars 32 assists in exposing more of the evaporative liquid flowing across elongated bars 32 to the air moving across the splash fill arrangement, without unduly impeding the air flow.

[0010] Referring now to FIG. 3, a second embodiment of a splash fill arrangement is shown as comprising support plate 40 and arrays of angled elongated bars 44 and array of horizontal elongated bars 46. Support plate 40 itself is seen to be hung or otherwise supported by support bars 42 which can be comprised of structural plastic, or aluminum or galvanized steel or stainless steel. The composition of support plate 40 and elongated bars 44 and 46 are as set forth above. However, elongated bars 44 in the upper array are shown to be installed in support plate 40 at an angle to the horizontal. Such angle is preferably between 5 and 45 degrees. Horizontal elongated

bars 46 between the arrays of elongated bars 44 are seen to be installed at a zero degree angle to the horizontal. Such combined angled and horizontal installation of elongated bars 44 and 46, respectively, is designed to improve the heat exchanging performance of the direct heat exchange system into which the splash fill arrangement is installed.

[0011] Air flow is depicted as from left to right in Fig. 3 as shown by the arrow. Water flow is generally downward. This angled orientation of elongated bars 44 assists in exposing more of the evaporative liquid flowing across elongated bars 44 to the air moving across the splash fill arrangement, without unduly impeding the air flow. The horizontal orientation of elongated bars 46 assists in directing the airflow in generally horizontal direction.

[0012] The vertical gap 43 between elongated bars 44 and 46 varies such that the size of gap 43 near top edge 47 of support plate 40 is smallest and gradually increases toward the bottom edge 48. The gradual increase in the vertical gap 43 between elongated bars 44 and 46 helps to counteract the difference in air pull pressure along the outlet side 59 by the fan 12 that is generally located near the corner of top edge 47 and outlet side 59.

[0013] Referring now to FIG. 4, a third embodiment of a splash fill arrangement is shown as comprising support plate 50 and an inlet array of elongated bars 54, a central array of elongated bars 52 and an outlet array of elongated bars 56. The composition of support plate 50 and elongated bars 52, 54 and 56 are as set forth above. However, elongated bars 54 in the inlet array are shown to be installed in support plate 50 at an upward angle to the horizontal. Such angle is preferably between 5 and 45 degrees. Such angled installation of elongated bars 54 is designed to improve the heat exchanging performance of the direct heat exchange system into which the splash fill arrangement is installed by assisting in keeping more of the generally downward flowing water from exiting the splash fill arrangement through inlet side 57. Elongated bars 52 in the center array are seen to be installed at a downward degree angle to the horizontal. Such angle is preferably between 5 and 45 degrees. Elongated bars 56 in the outlet array are shown to be installed in support plate 50 at an increased downward angle to the horizontal. Such angle is preferably between 20 and 50 degrees. Such angled installation of elongated bars 56 is designed to improve the heat exchanging performance of the direct heat exchange system into which the splash fill arrangement is installed by assisting in keeping more of the generally downward flowing water from exiting the splash fill arrangement through outlet side 59. Air flow is depicted as from left to right in Fig. 4 as shown by the arrow. Water flow is generally downward. This angled orientation of center section elongated bars 52 assists in exposing more of the evaporative liquid flowing across elongated bars 52 to the air moving across the splash fill arrangement, without unduly impeding the air flow.

[0014] Referring now to Fig. 5, five preferred embodiments of the elongated bars are shown at 60, 62, 63, 64 and 70. Elongated bar 60 is seen to have a generally smooth edged rectangular cross sectional configuration. Elongated bar 62 is seen to have a generally smooth edged rectangular cross section; however, two ridges 66 and 68 extend from a lower leading edge of elongated bar 62. Elongated bar 64 is seen to have a generally smooth edged rectangular cross sectional configuration; however, the top surface thereof is raised from a flat arrangement and the bottom surface thereof is indented from a flat arrangement. Elongated bar 63 is seen to have a generally smooth edged rectangular cross sectional configuration; however, the top surface thereof is indented from a flat arrangement and the bottom surface thereof is lowered from a flat arrangement. Elongated bar 70 is seen to have a generally smooth edge rectangular cross sectional configuration; however, the bottom surface thereof includes an opening 72.

Claims

1. A splash fill arrangement for use in a direct heat exchanger, comprising
a support plate and a plurality of elongated bars, the support plate including a plurality of openings, each support plate opening adapted to receive an elongated bar,
at least one of the elongated bars set at an angle from the horizontal of between 5 and 45 degrees.
2. The splash fill arrangement of claim 1 wherein at least one of the elongated bars has a generally smooth edged rectangular cross section.
3. The splash fill arrangement of claim 1 or 2 wherein at least one of the elongated bars has a generally smooth edged rectangular cross section with at least one raised ridge along a lower surface of the elongated bar.
4. The splash fill arrangement of claim 1, 2 or 3 wherein at least one of the elongated bars has a generally smooth edged rectangular cross section with a top surface thereof generally raised from the horizontal and a bottom surface thereof indented from the horizontal.
5. The splash fill arrangement of any preceding claim further comprising
a second plurality of elongated bars located beneath the plurality of elongated bars and wherein at least one of the second plurality of elongated bars is set at an angle of about 0 degrees from the horizontal.
6. The splash fill arrangement of any preceding claim further comprising
a second plurality of elongated bars, the second plurality of elongated bars positioned adjacent an air inlet of the direct heat exchanger and wherein at least one of the second plurality of elongated bars is set at an upward angle from the horizontal of between 5 and 45 degrees, and
a third plurality of elongated bars, the third plurality of elongated bars positioned adjacent an air outlet of the direct heat exchanger and wherein at least one of the third plurality of elongated bars is set at a downward angle from the horizontal of between 20 and 50 degrees.
7. The splash fill arrangement of any preceding claim further comprising
vertical gaps between elongated bars wherein the gaps are generally smallest near the top of support plate and gradually increase toward the bottom of plate.
8. A splash fill arrangement for use in a direct heat exchanger, comprising
a support plate and a first plurality of elongated bars, the support plate including a plurality of openings, each support plate opening adapted to receive an elongated bar from the first plurality of elongated bars,
a second plurality of elongated bars, each support plate opening adapted to receive an elongated bar from the second plurality of elongated bars.
at least one of the first plurality of elongated bars set at an angle from the horizontal of between 5 and 45 degrees,
at least one of the second plurality of elongated bars set at an angle of about 0 degrees from the horizontal, and wherein the second plurality of elongated bars is located generally between the first plurality of elongated bars.
9. A splash fill arrangement for use in a direct heat exchanger, comprising a support plate and a first plurality of elongated bars,
the support plate including a plurality of openings, each support plate opening adapted to receive an elongated bar from the first plurality of elongated bars,
a second plurality of elongated bars, the second plurality of elongated bars positioned adjacent an air inlet of the direct heat exchanger and wherein at least one of the second plurality of elongated bars is set at an upward angle from the horizontal of between 5 and 45 degrees, and
a third plurality of elongated bars, the third plurality of elongated bars positioned adjacent an air outlet of the direct heat exchanger and wherein at least one of the third plurality of elongated bars is set at a downward angle from the horizontal of between 20 and 50 degrees.

10. The splash fill arrangement of claim 8 or 9 wherein at least one of the first plurality of elongated bars has a generally smooth edged rectangular cross section.
11. The splash fill arrangement of any of claims 8, 9 or 10 wherein at least one of the first plurality of elongated bars has a generally smooth edged rectangular cross section with at least one raised ridge along a lower surface of the elongated bar. 5 10
12. The splash fill arrangement of any of claims 8, 9, 10 or 11 wherein at least one of the first plurality of elongated bars has a generally smooth edged rectangular cross section with a top surface thereof generally raised from the horizontal and a bottom surface thereof indented from the horizontal. 15
13. The splash fill arrangement of any of claims 8, 9, 10, 11 or 12 further comprising vertical gaps between elongated bars wherein the gaps are generally smallest near the top of support plate and gradually increase toward the bottom of plate. 20 25
14. The splash fill arrangement of any preceding claim wherein at least one of the first plurality of elongated bars has an opening in a lower surface of the elongated bar. 30

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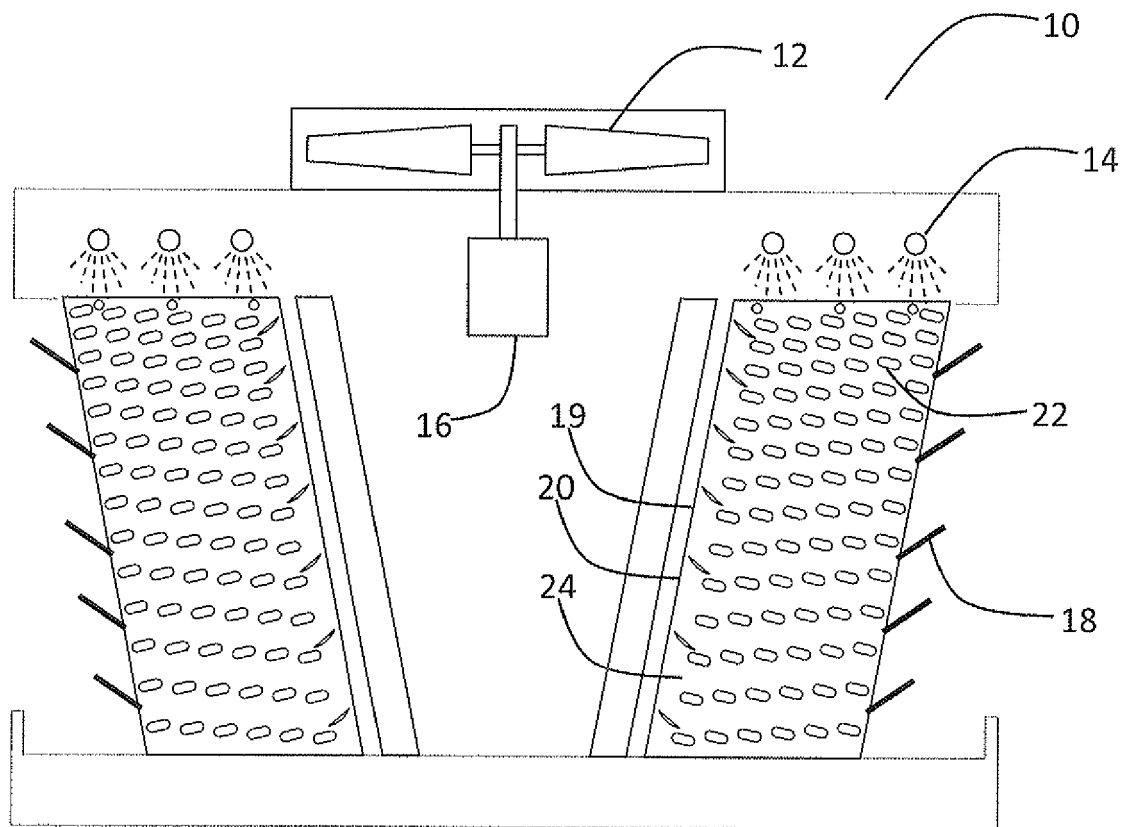


FIG. 1

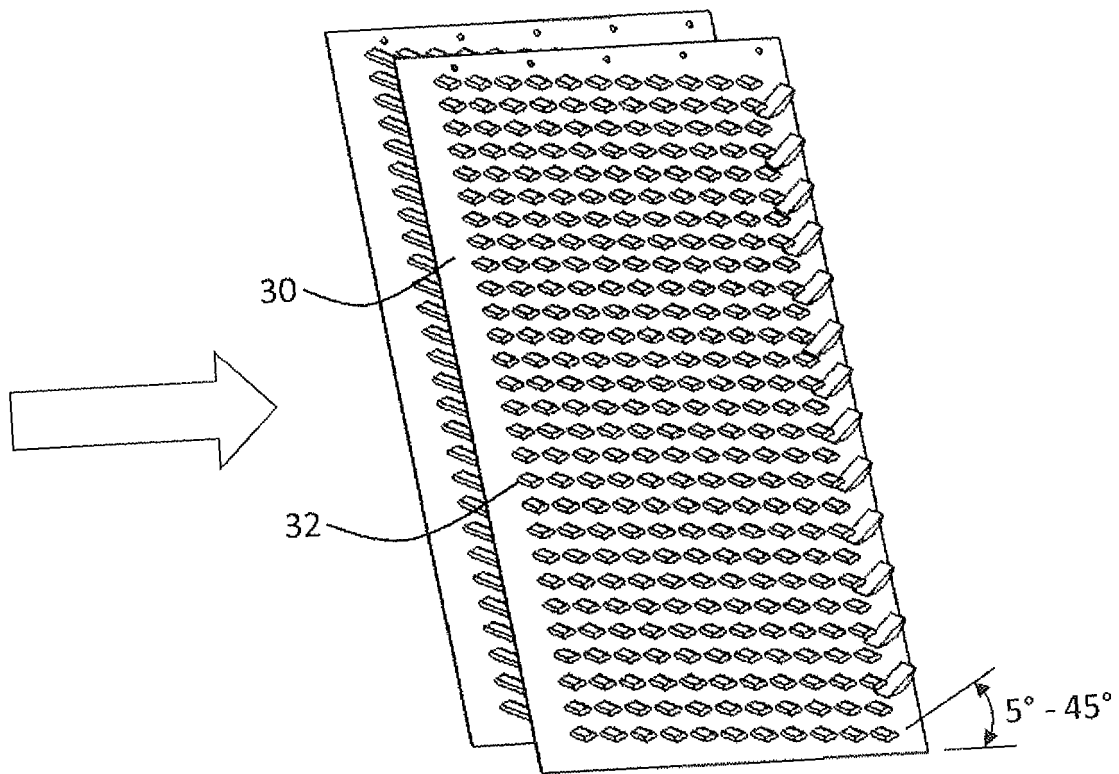


FIG. 2

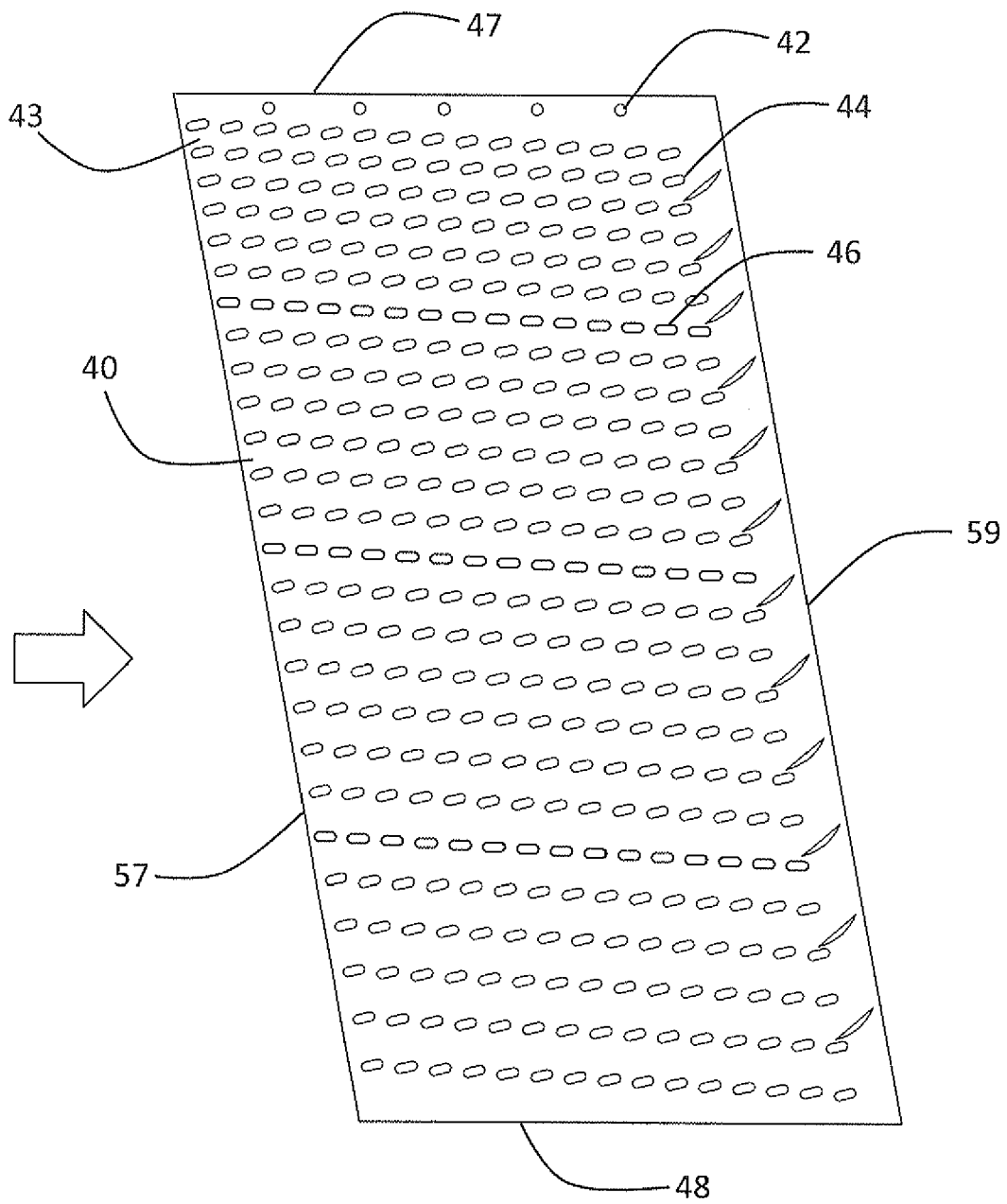


FIG. 3

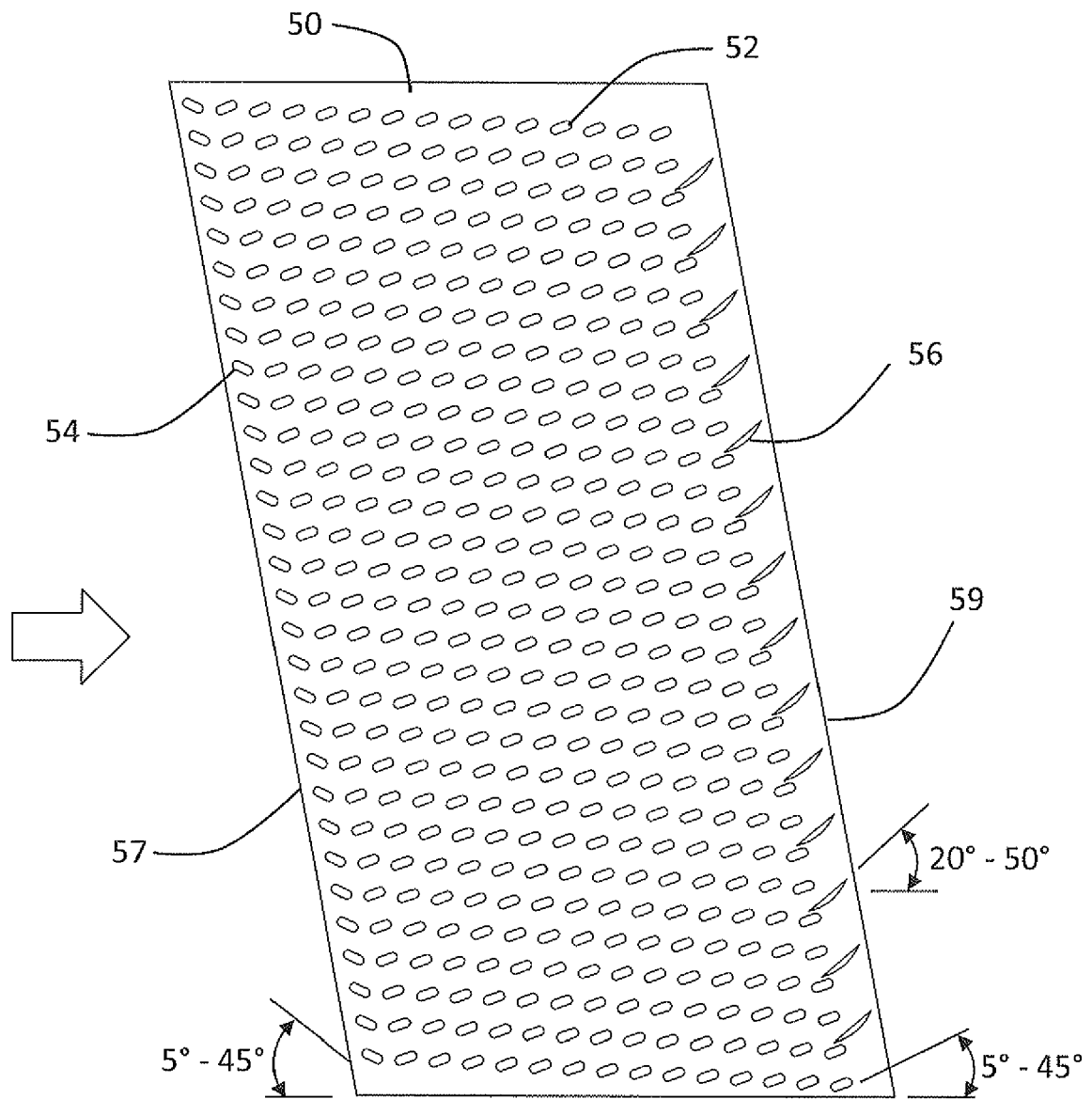


FIG. 4

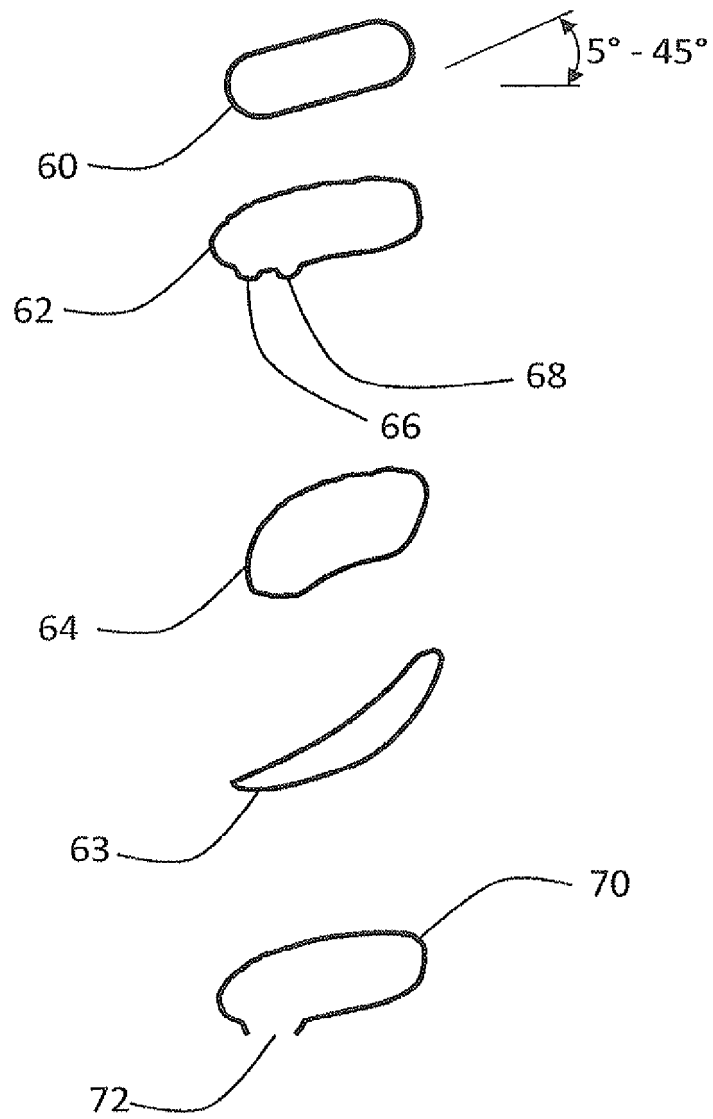


FIG. 5



EUROPEAN SEARCH REPORT

 Application Number
 EP 16 19 5155

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DOCUMENTS CONSIDERED TO BE RELEVANT			
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The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 21 March 2017	Examiner Vassoille, Bruno
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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**ANNEX TO THE EUROPEAN SEARCH REPORT
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