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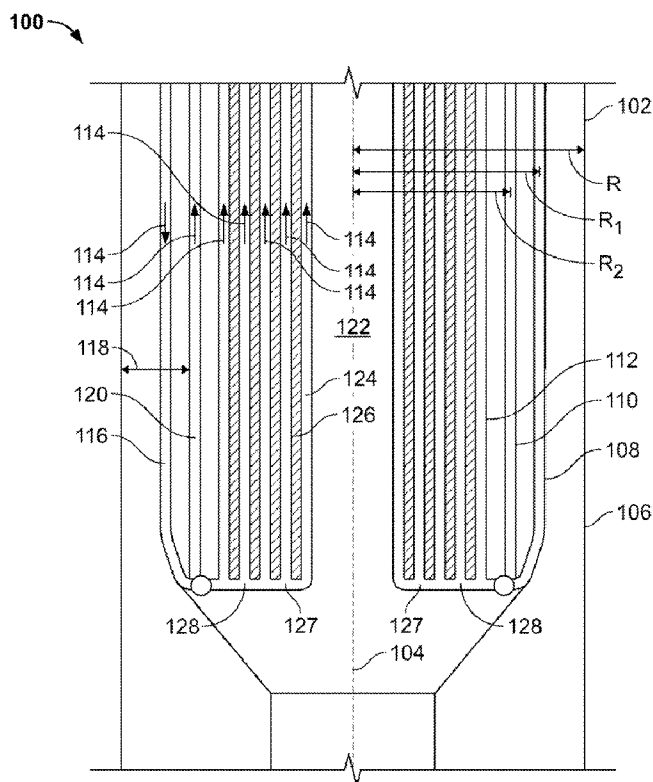


FIG. 2

(57) Abstract: A method for fabricating a syngas cooler is provided. The method includes coupling a tube cage within the syngas cooler, and coupling a plurality of platens (112) to the tube cage (127) to facilitate steam production in the syngas cooler. At least a first platen has at least one of a length that is larger than a length of a second platen, a non-linear geometry, and an angular position that is oblique with respect to a wall of the syngas cooler.

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METHODS FOR FABRICATING SYNGAS COOLER PLATENS AND SYNGAS COOLER PLATENS

BACKGROUND OF THE INVENTION

This invention relates generally to gasification systems, and more specifically, to methods and systems for fabricating syngas cooler platens.

At least some known gasification systems convert a mixture of fuel, air or oxygen, steam, and/or limestone into an output of partially combusted gas, sometimes referred to as "syngas". The hot combustion gases are supplied to the combustor of a gas turbine engine, which powers a generator used to supply electrical power to a power grid. Exhaust from at least some known gas turbine engines is supplied to a heat recovery steam generator that generates steam for driving a steam turbine. Power generated by the steam turbine may also be used to drive an electrical generator that provides electrical power to the power grid.

Further, some known gasification systems recover heat from the syngas to generate additional steam for powering the steam turbine. Typically, the steam is generated by passing the syngas over the platens of a syngas cooler. The platens are arrays of boiler tubes that create steam as heat is transferred from the syngas to boiler feedwater flowing within the boiler tubes. However, some known platen designs may provide only limited radiant and convective heat extraction because solids within the syngas become deposited on the surface of the platens. Accordingly, heat transfer from the syngas to the boiler feedwater may be reduced and, thus, steam production may be limited. One known method for preventing excessive deposits of the solids within the syngas includes orienting the tubes of the platens in a vertical fashion and spacing the tubes a distance from a centerline of syngas flow. However, such designs are often cost prohibitive and/or increase the size and/or weight of the syngas cooler.

BRIEF DESCRIPTION OF THE INVENTION

In one aspect, a method for fabricating a syngas cooler is provided. The method includes coupling a tube cage within the syngas cooler, and coupling a plurality of

platens to the tube cage to facilitate steam production in the syngas cooler. At least a first platen has at least one of a length that is larger than a length of a second platen, a non-linear geometry, and an angular position that is oblique with respect to a wall of the syngas cooler.

In another aspect, a syngas cooler is provided. The syngas cooler includes a tube cage and a plurality of platens coupled to the tube cage to facilitate steam production in the syngas cooler. At least a first platen has at least one of a length that is larger than a length of a second platen, a non-linear geometry, and an angular position that is oblique with respect to a wall of the syngas cooler.

In yet another aspect, a plurality of platens are provided. The platens are configured to couple to a tube cage of a syngas cooler to facilitate steam production in the syngas cooler. At least a first platen has at least one of a length that is larger than a length of a second platen, a non-linear geometry, and an angular position that is oblique with respect to a wall of the syngas cooler.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is schematic view of an exemplary integrated gasification combined cycle (IGCC) system;

Figure 2 is a schematic cross-sectional view of an exemplary syngas cooler that may be used with the system shown in Figure 1;

Figure 3 is an exemplary embodiment of a plurality of platens that may be used with the syngas cooler shown in Figure 2;

Figure 4 is an alternative embodiment of the plurality of platens shown in Figure 3.

Figure 5 is another alternative embodiment of a plurality of platens that may be used with the syngas cooler shown in Figure 2;

Figure 6 is a further alternative embodiment of a plurality of platens that may be used with the syngas cooler shown in Figure 2;

Figure 7 is yet another alternative embodiment of a plurality of platens that may be used with the syngas cooler shown in Figure 2;

Figure 8 is another alternative embodiment of a plurality of platens that may be used with the syngas cooler shown in Figure 2;

Figure 9 is another alternative embodiment of a plurality of platens that may be used with the syngas cooler shown in Figure 2;

Figure 10 is a further alternative embodiment of a plurality of platens that may be used with the syngas cooler shown in Figure 2;

Figure 11 is a top view of the plurality of platens shown in Figure 15;

Figure 12 is yet another alternative embodiment of a plurality of platens that may be used with the syngas cooler shown in Figure 2; and

Figure 13 is another alternative embodiment of a plurality of platens that may be used with the syngas cooler shown in Figure 2.

DETAILED DESCRIPTION OF THE INVENTION

The present invention provides a plurality of platens for use in a syngas cooler, wherein at least one platen either has a length that is longer than the length of a second platen, has a non-linear geometry, and/or is coupled to a tube cage of the syngas cooler at an oblique angle with respect to a wall of the syngas cooler. Specifically, the present invention provides various configurations in which the known geometric shape of platens is modified from a uniformly straight, radially positioned construction to a different geometric configuration wherein different numbers, angles, and/or lengths of the platens are used. The different platen designs described herein facilitate enhancing radiant and convective heat extraction between the syngas and the boiler feed water within the tubes of the platens. Further, such platen configurations facilitate the design of a more compact and/or cost effective syngas cooler.

It should be noted that although the present invention is described with respect to platens that may be used in a syngas cooler, one of ordinary skill in the art should understand that the present invention is not limited to being used only in syngas coolers. Rather, the present invention may be used in any system that utilizes heat exchange. Further, for simplicity, the present invention is described herein only with respect to producing steam as a by-product of syngas production. However, as would be appreciated by one of ordinary skill in the art, the present invention is not limited to producing steam; but rather, the present invention may be used to produce any by-product of heat exchange.

Figure 1 is a schematic diagram of an exemplary integrated gasification combined-cycle (IGCC) power generation system 10. IGCC system 10 generally includes a main air compressor 12, an air separation unit (ASU) 14 coupled in flow communication to compressor 12, a gasifier 16 coupled in flow communication to ASU 14, a syngas cooler 18 coupled in flow communication to gasifier 16, a gas turbine engine 20 coupled in flow communication to syngas cooler 18, and a steam turbine 22 coupled in flow communication to syngas cooler 18.

In operation, compressor 12 compresses ambient air that is then channeled to ASU 14. In the exemplary embodiment, in addition to compressed air from compressor 12, compressed air from a gas turbine engine compressor 24 is supplied to ASU 14. Alternatively, compressed air from gas turbine engine compressor 24 is supplied to ASU 14, rather than compressed air from compressor 12 being supplied to ASU 14. In the exemplary embodiment, ASU 14 uses the compressed air to generate oxygen for use by gasifier 16. More specifically, ASU 14 separates the compressed air into separate flows of oxygen (O_2) and a gas by-product, sometimes referred to as a "process gas". The O_2 flow is channeled to gasifier 16 for use in generating partially combusted gases, referred to herein as "syngas" for use by gas turbine engine 20 as fuel, as described below in more detail.

The process gas generated by ASU 14 includes nitrogen and will be referred to herein as "nitrogen process gas" (NPG). The NPG may also include other gases such as, but not limited to, oxygen and/or argon. For example, in the exemplary embodiment, the

NPG includes between about 95% and about 100% nitrogen. In the exemplary embodiment, at least some of the NPG flow is vented to the atmosphere from ASU 14, and at some of the NPG flow is injected into a combustion zone (not shown) within a gas turbine engine combustor 26 to facilitate controlling emissions of engine 20, and more specifically to facilitate reducing the combustion temperature and reducing nitrous oxide emissions from engine 20. In the exemplary embodiment, IGCC system 10 includes a compressor 28 for compressing the nitrogen process gas flow before being injected into the combustion zone of gas turbine engine combustor 26.

In the exemplary embodiment, gasifier 16 converts a mixture of fuel supplied from a fuel supply 30, O₂ supplied by ASU 14, steam, and/or limestone into an output of syngas for use by gas turbine engine 20 as fuel. Although gasifier 16 may use any fuel, gasifier 16, in the exemplary embodiment, uses coal, petroleum coke, residual oil, oil emulsions, tar sands, and/or other similar fuels. Furthermore, in the exemplary embodiment, the syngas generated by gasifier 16 includes carbon dioxide.

In the exemplary embodiment, syngas generated by gasifier 16 is channeled to syngas cooler 18 to facilitate cooling the syngas, as described in more detail below. The cooled syngas is channeled from cooler 18 to a clean-up device 32 for cleaning the syngas before it is channeled to gas turbine engine combustor 26 for combustion thereof. Carbon dioxide (CO₂) may be separated from the syngas during clean-up and, in the exemplary embodiment, may be vented to the atmosphere. Gas turbine engine 20 drives a generator 34 that supplies electrical power to a power grid (not shown). Exhaust gases from gas turbine engine 20 are channeled to a heat recovery steam generator 36 that generates steam for driving steam turbine 22. Power generated by steam turbine 22 drives an electrical generator 38 that provides electrical power to the power grid. In the exemplary embodiment, steam from heat recovery steam generator 36 is supplied to gasifier 16 for generating syngas.

Furthermore, in the exemplary embodiment, system 10 includes a pump 40 that supplies boiled water from steam generator 36 to syngas cooler 18 to facilitate cooling the syngas channeled from gasifier 16. The boiled water is channeled through syngas

cooler 18 wherein the water is converted to steam. The steam from cooler 18 is then returned to steam generator 36 for use within gasifier 16, syngas cooler 18, and/or steam turbine 22.

Figure 2 shows a schematic cross-sectional view of an exemplary syngas cooler 100 that may be used with system 10. In the exemplary embodiment, syngas cooler 100 is a radiant syngas cooler. Syngas cooler 100 includes a pressure vessel shell 102 having a top opening (not shown) and a bottom opening (not shown) that are generally concentrically aligned with each other along a cooler centerline 104. As referred to herein, an “axial” direction is a direction that is substantially parallel to centerline 104, an “upward” direction is a direction that is generally towards the shell top opening, and a “downward” direction is a direction that is generally towards the bottom opening. Syngas cooler 100 has a radius R measured from centerline 104 to an outer surface 106 of shell 102. Furthermore, in the exemplary embodiment, a top (not shown) of cooler 100 includes a plurality of downcomer openings (not shown) and a plurality of riser openings (not shown) that circumscribe the top opening. In the exemplary embodiment, shell 102 is fabricated from a pressure vessel quality steel, such as, but not limited to, a chromium molybdenum steel. As such, shell 102 is facilitated to withstand the operating pressures of syngas flowing through syngas cooler 100. Moreover, in the exemplary embodiment, the shell top opening is coupled in flow communication with gasifier 16 for receiving syngas discharged from gasifier 16. The bottom opening of shell 102, in the exemplary embodiment, is coupled in flow communication with a slag collection unit (not shown) to enable the collection of solid particles formed during gasification and/or cooling.

Within shell 102, in the exemplary embodiment, are a plurality of heat transfer medium supply lines (also referred to herein as “downcomers”) 108, a heat transfer wall (also referred to herein as a “tube wall”) 110, and a plurality of heat transfer panels (also referred to herein as “platens”) 112. More specifically, in the exemplary embodiment, downcomers 108 are positioned radially inward of shell 102, tube wall 110 is radially inward of downcomers 108, and platens 112 are arranged within tube wall 110 such that tube wall 110 substantially circumscribes platens 112. Generally,

in the exemplary embodiment, downcomers 108 are located at a radius R_1 outward from centerline 104, and tube wall 110 is located at a radius R_2 from centerline 104, wherein radius R_1 is longer than radius R_2 , and radius R is longer than radii R_1 and R_2 . Alternatively, shell 102, downcomers 108, tube wall 110, and/or platens 112 are arranged in other orientations.

In the exemplary embodiment, downcomers 108 supply a heat transfer medium 114, such as, for example, water from steam generator 36, to syngas cooler 100, as described herein. More specifically, downcomers 108 supply heat transfer medium 114 to tube wall 110 and platens 112 via a lower manifold 200, as is described in more detail below. Lower manifold 200, in the exemplary embodiment, is coupled proximate to the cooler bottom opening, and, as such, is downstream from the cooler top opening through which syngas enters cooler 100. In the exemplary embodiment, downcomers 108 include tubes 116 fabricated from a material that enables cooler 100 and/or system 10 to function as described herein. Furthermore, in the exemplary embodiment, a gap 118 defined between shell 102 and tube wall 110 may be pressurized to facilitate decreasing stresses induced to tube wall 110.

In the exemplary embodiment, tube wall 110 includes a plurality of circumferentially-spaced, axially-aligned tubes 120 coupled together with a membrane (also referred to herein as a "web") (not shown). Although in the exemplary embodiment, tube wall 110 includes only one row of tubes 120, in other embodiments, tube wall 110 may include more than one row of tubes 120. More specifically, in the exemplary embodiment, the membrane and tubes 120 are coupled together such that tube wall 110 is substantially impermeable to syngas. As such, tube wall 110 substantially retains the syngas in an inner portion 122 of cooler 100 that is effectively isolated from downcomers 108 and/or shell 102. As such, tube wall 110 defines an enclosure through which syngas may flow. In the exemplary embodiment, heat is transferred from the syngas retained within tube wall 110 to heat transfer medium 114 flowing through tubes 120. Tubes 120 and/or the membrane are fabricated from a material having heat transfer properties that enable cooler 100 to function as described herein. Furthermore, in the exemplary embodiment, tube wall 110 is coupled to risers

extending through the top of shell 102 (not shown) such that the heated heat transfer medium 114 may be channeled from cooler 100 to, for example, heat recovery steam generator 36 (shown in Figure 1).

In the exemplary embodiment, platens 112 each include a plurality of tubes 124 coupled together with a membrane 126. Each platen 112 may include any number of tubes 124 that enables cooler 100 to function as described herein. Although platens 112 are shown in Figure 2 as being oriented generally radially with generally axially-aligned tubes 124, platens 112 and/or tubes 124 may be oriented and/or configured in any suitable orientation and/or configuration that enables cooler 100 to function as described herein. Moreover, in the exemplary embodiment, platens 112 are coupled to a tube cage 127. Specifically, in the exemplary embodiment, tube cage 127 includes a lower inlet tube 128 and an upper outlet tube (not shown). Platens 112 are coupled to lower inlet tube 128 and to the upper outlet tube (not shown). More specifically, in the exemplary embodiment, platens 112 extend in a substantially perpendicular array between lower inlet tube 128 and the upper outlet tube. Alternatively, platens 112 may be oriented at any angle with respect to tube 128 and/or may be arranged in a different array from lower inlet tube 128.

Figure 3 is an exemplary embodiment of a plurality of platens 200 that may be used with syngas cooler 100. Figure 4 is an alternative embodiment of platens 200. In the exemplary embodiments, platens 200 include a first plurality of platens 202 that each have a first length L_1 , and a second plurality of platens 204 that each have a second length L_2 that is greater than first length L_1 . Platens 200 are positioned circumferentially about a syngas cooler centerline 104. Specifically, although Figure 3 and Figure 4 illustrate only a semi-circle arrangement of platens 200, as will be appreciated by one of ordinary skill in the art, in one embodiment, platens 200 substantially circumscribe centerline 104. In an alternative embodiment, platens 200 extend any suitable arcuate distance about centerline 104.

In the embodiment illustrated in Figure 3, a single platen 202 is circumferentially positioned between each pair of adjacent platens 204. In the embodiment illustrated in Figure 4, a pair of platens 202 are circumferentially positioned between each pair

of adjacent platens 204. In an alternative embodiment, any number of platens 202 may be circumferentially positioned between each pair of adjacent platens 204. In yet another embodiment, any number of platens 204 may be positioned between adjacent pairs of platens 202. Further, in the exemplary embodiments, each platen 200 extends substantially radially inward from a wall or shell (shown in Figure 2) of syngas cooler 100 towards centerline 104. In an alternative embodiment, platens 200 extend at any suitable oblique angle from the wall of syngas cooler 100. Moreover, platens 200 are configured to couple to a tube cage (shown in Figure 2) and extend substantially vertically through syngas cooler 100. Further, the configuration of platens 200, having alternating lengths L_1 and L_2 , facilitates reducing an overall size of platens 200 to less than a size of known platens, and also increases the exposure of platens 200 to the flowpath of syngas cooler 100 in comparison to known syngas cooler platens.

During operation, a syngas stream discharged from the gasifier (shown in Figure 1) is channeled into the top of syngas cooler 100. The syngas flows along platens 200 to facilitate heating boiler feedwater flowing through platens 200 to produce steam. By its nature the syngas flowing through syngas cooler 100 is optically dense with particulate matter that limits radiation heat transfer to platens 200 due to limited sight pathways. Further, the particulate matter within the syngas stream may have a tendency to deposit on platens 200, thus reducing heat transfer. However, in the exemplary embodiment, the vertical orientation and the increased exposure of platens 200 to the flowpath of syngas facilitate reducing the deposition of solids from the syngas stream. As a result, heat transfer from the syngas stream to the boiler feedwater and steam production are facilitated to be increased. Moreover, the reduced size of platens 200 facilitates reducing an overall length and/or diameter of syngas cooler 100 without adversely affecting steam production and/or increasing the fabrication costs that are dependant on the size of syngas cooler 100.

Figure 5 illustrates another embodiment of a plurality of platens 250 that may be used with syngas cooler 100. In the exemplary embodiment, platens 250 include a first plurality of platens 252 and a second plurality of platens 254. In the exemplary embodiment, platens 252 are substantially linear; however, as will be appreciated by one of ordinary skill in the art, in an alternative embodiment, platens 252 are non-

linear. Further, in the exemplary embodiment, platens 254 are substantially arcuate; however, as will be appreciated by one of ordinary skill in the art, in an alternative embodiment, platens 254 are substantially linear and/or have another non-linear shape.

Platens 250 are spaced circumferentially about centerline 104. Specifically, although Figure 5 illustrates only a semi-circle of platens 250, as will be appreciated by one of ordinary skill in the art, in one embodiment, platens 250 are spaced entirely about centerline 104. In an alternative embodiment, platens 250 are spaced any arcuate distance about centerline 104 that enables syngas cooler 100 to function as described herein. Further, in the exemplary embodiment, platens 252 extend substantially radially inward from a wall or shell (shown in Figure 2) of syngas cooler 100 towards centerline 104. In an alternative embodiment, platens 252 extend at an oblique angle from the wall of syngas cooler 100. Platens 254 extend substantially circumferentially around centerline 104 along an inner perimeter of the wall of the syngas cooler. Platens 254 also extend outward at an angle from platens 252. Specifically, in the exemplary embodiment, each platen 254 extends a distance D_1 from a platen 252 that enables each platen 254 to overlap an adjacent platen 252 and an adjacent platen 254. In an alternative embodiment, platens 254 do not overlap adjacent platens 252 and/or 254. In yet another embodiment, platens 254 overlap an adjacent platen 252, but do not overlap an adjacent platen 254. In a further embodiment, platens 254 overlap any number of adjacent platens 252 and/or 254 that enables syngas cooler 100 to function as described herein.

Moreover, platens 250 are configured to couple to a tube cage (shown in Figure 2) and extend substantially vertically through syngas cooler 100. Further, the L-shaped configuration of platens 250 facilitates reducing an overall size of platens 250 as compared to a size of known platens, and also increases an exposure of platens 250 to a flowpath of syngas cooler 100 in comparison to known syngas cooler platens.

During operation, a syngas stream discharged from the gasifier (shown in Figure 1) is channeled into the top of syngas cooler 100. The syngas flows along platens 250 to facilitate heating boiler feedwater flowing through platens 250 to produce steam. By

its nature the syngas flowing through syngas cooler 100 is optically dense with particulate matter that limits radiation heat transfer to platens 250 due to limited sight pathways. Further, the particulate matter within the syngas stream may have a tendency to deposit on platens 250, thus reducing heat transfer. However, in the exemplary embodiment, the vertical orientation and the increased exposure of platens 250 to the flowpath of syngas facilitate reducing the deposition of solids from the syngas stream. As a result, heat transfer from the syngas stream to the boiler feedwater and steam production are facilitated to be increased. Moreover, the reduced size of platens 250 facilitates reducing an overall length and/or diameter of syngas cooler 100 without adversely affecting steam production and/or increasing the fabrication costs that are dependant on the size of syngas cooler 100.

Figure 6 is a further embodiment of a plurality of platens 300 that may be used with syngas cooler 100. In the exemplary embodiment, platens 300 are substantially arcuate. Further, platens 300 are spaced circumferentially about centerline 104. Specifically, although Figure 6 illustrates only a semi-circle of platens 300, as will be appreciated by one of ordinary skill in the art, in one embodiment, platens 300 are spaced entirely about centerline 104. In an alternative embodiment, platens 300 are spaced any suitable distance about centerline 104 that enables syngas cooler 100 to function as described herein. Further, in the exemplary embodiment, platens 300 extend substantially radially inward from a wall or shell (shown in Figure 2) of syngas cooler 100 towards centerline 104. In an alternative embodiment, platens 300 extend at an oblique angle from the wall of the syngas cooler. In one embodiment, platens 300 have different lengths. Specifically, platens 300 include a first plurality of platens 302 that have a first length L_3 and a second plurality of platens 304 that have a second length L_4 that is longer than first length L_3 . In another embodiment, platens 300 each have the same length.

Moreover, platens 300 are configured to couple to a tube cage (shown in Figure 2) and extend substantially vertically through syngas cooler 100. Further, the arcuate configuration of platens 300 reduces an overall size of platens 300 to less than a size of known platens, and also increases an exposure of platens 300 to a flowpath of syngas cooler 100 in comparison to known syngas cooler platens.

During operation, a syngas stream discharged from the gasifier (shown in Figure 1) is channeled into the top of syngas cooler 100. The syngas flows along platens 300 to facilitate heating boiler feedwater flowing through platens 300 to produce steam. By its nature the syngas flowing through syngas cooler 100 is optically dense with particulate matter that limits radiation heat transfer to platens 300 due to limited sight pathways. Further, the particulate matter within the syngas stream may have a tendency to deposit on platens 300, thus reducing heat transfer. However, in the exemplary embodiment, the vertical orientation and the increased exposure of platens 300 to the flowpath of syngas facilitate reducing the deposition of solids from the syngas stream. As a result, heat transfer from the syngas stream to the boiler feedwater and steam production are facilitated to be increased. Moreover, the reduced size of platens 300 facilitates reducing an overall length and/or diameter of syngas cooler 100 without adversely affecting steam production and/or increasing the fabrication costs that are dependant on the size of syngas cooler 100.

Figure 7 is yet another embodiment of a plurality of platens 350 that may be used with syngas cooler 100. In the exemplary embodiment, platens 350 are substantially linear and have the same length L_5 . In an alternative embodiment, platens 350 are substantially non-linear. In yet another embodiment, platens 350 have differing lengths. Platens 350 are spaced circumferentially about centerline 104. Specifically, although Figure 7 illustrates only a semi-circle of platens 350, as will be appreciated by one of ordinary skill in the art, in one embodiment, platens 350 are spaced entirely about centerline 104. In an alternative embodiment, platens 350 are spaced any suitable distance about centerline 104 that enables syngas cooler 100 to function as described herein. Further, in the exemplary embodiment, platens 350 extend at an oblique angle from a wall or shell (shown in Figure 2) of syngas cooler 100 towards centerline 104.

Moreover, platens 350 are configured to couple to a tube cage (shown in Figure 2) and extend substantially vertically through syngas cooler 100. Further, the configuration of platens 350, extending at an oblique angle with respect to the syngas cooler wall, reduces an overall size of platens 350 to less than a size of known platens,

and also increases the exposure of platens 350 to a flowpath of syngas cooler 100 in comparison to known syngas cooler platens.

During operation, a syngas stream discharged from the gasifier (shown in Figure 1) is channeled into the top of syngas cooler 100. The syngas flows along platens 350 to facilitate heating boiler feedwater flowing through platens 350 to produce steam. By its nature the syngas flowing through syngas cooler 100 is optically dense with particulate matter that limits radiation heat transfer to platens 350 due to limited sight pathways. Further, the particulate matter within the syngas stream may have a tendency to deposit on platens 350, thus reducing heat transfer. However, in the exemplary embodiment, the vertical orientation and the increased exposure of platens 350 to the flowpath of syngas facilitate reducing the deposition of solids from the syngas stream. As a result, heat transfer from the syngas stream to the boiler feedwater and steam production are facilitated to be increased. Moreover, the reduced size of platens 350 facilitates reducing an overall length and/or diameter of syngas cooler 100 without adversely affecting steam production and/or increasing the fabrication costs that are dependant on the size of syngas cooler 100.

Figure 8 is an alternative embodiment of a plurality of platens 400 that may be used with syngas cooler 100. Platens 400 include a first plurality of platens 402 and a second plurality of platens 404. Platens 400 are spaced circumferentially about centerline 104. Specifically, although Figure 8 illustrates only a semi-circle of platens 400, as will be appreciated by one of ordinary skill in the art, in one embodiment, platens 400 are spaced entirely about centerline 104. In an alternative embodiment, platens 400 are spaced any distance about centerline 104 that enables platens 400 to function as described herein. In the exemplary embodiment, platens 404 are positioned radially inward from platens 402. Specifically, platens 402 extend radially inward from the wall or shell (shown in Figure 2) of syngas cooler 100 toward centerline 104, and platens 404 extend inward from platens 402 toward centerline 104. In an alternative embodiment, platens 402 extend at an oblique angle from the wall of the syngas cooler. Further, in the exemplary embodiment, platens 404 extend at an oblique angle from platens 402. Specifically, a first platen 406 extends from each platen 402 obliquely in a first direction, and a second platen 408 extends from

each platen 402 obliquely in the opposite direction, such that one platen 402 and a pair of platens 404 form a Y-shape in a plane perpendicular to axial centerline 104.

In the exemplary embodiment, platens 400 are substantially linear; however, as will be appreciated by one of ordinary skill in the art, in an alternative embodiment, platens 400 are non-linear. Further, in the exemplary embodiment, platens 402 have a length L_6 and platens 404 have a length L_7 that is longer than length L_6 . In an alternative embodiment, length L_6 that is longer than length L_7 . In another embodiment, length L_6 is substantially the same as length L_7 . In a further embodiment, platens 402 have differing lengths and/or platens 404 have differing lengths.

Moreover, platens 400 are configured to couple to a tube cage (shown in Figure 2) and extend substantially vertically through syngas cooler 100. Further, the Y-shaped configuration of platens 400 reduces an overall size of platens 400 to less than a size of known platens, and also increases the exposure of platens 400 to a flowpath of syngas cooler 100 in comparison to known syngas cooler platens.

During operation, a syngas stream discharged from the gasifier (shown in Figure 1) is channeled into the top of syngas cooler 100. The syngas flows along platens 400 to facilitate heating boiler feedwater flowing through platens 400 to produce steam. By its nature the syngas flowing through syngas cooler 100 is optically dense with particulate matter that limits radiation heat transfer to platens 400 due to limited sight pathways. Further, the particulate matter within the syngas stream may have a tendency to deposit on platens 400, thus reducing heat transfer. However, in the exemplary embodiment, the vertical orientation and the increased exposure of platens 400 to the flowpath of syngas facilitate reducing the deposition of solids from the syngas stream. As a result, heat transfer from the syngas stream to the boiler feedwater and steam production are facilitated to be increased. Moreover, the reduced size of platens 400 facilitates reducing an overall length and/or diameter of syngas cooler 100 without adversely affecting steam production and/or increasing the fabrication costs that are dependant on the size of syngas cooler 100.

Figure 9 is another embodiment of a plurality of platens 450 that may be used with syngas cooler 100. Platens 450 include a first plurality of platens 452 and a second plurality of platens 454. Platens 450 are spaced circumferentially about centerline 104. Specifically, although Figure 9 illustrates only a semi-circle of platens 450, as will be appreciated by one of ordinary skill in the art, in one embodiment, platens 450 are spaced entirely about centerline 104. In an alternative embodiment, platens 450 are spaced any distance about centerline 104 that enables syngas cooler 100 to function as described herein. In the exemplary embodiment, platens 452 are positioned radially inward from platens 454. Specifically, platens 452 extend radially outward from centerline 104 toward the wall or shell (shown in Figure 2) of syngas cooler 100, and platens 454 extend outward from platens 452 toward the wall of syngas cooler 100. In an alternative embodiment, platens 452 extend from centerline 104 at an oblique angle with respect to the wall of syngas cooler 100. Further, in the exemplary embodiment, platens 454 extend at an oblique angle from platens 452. Specifically, a first platen 456 extends from each platen 452 obliquely in a first direction, and a second platen 458 extends from each platen 452 obliquely in the opposite direction, such that one platen 452 and a pair of platens 454 form a Y-shape.

In the exemplary embodiment, platens 450 are substantially linear; however, as will be appreciated by one of ordinary skill in the art, in an alternative embodiment, platens 450 are non-linear. Further, in the exemplary embodiment, platens 452 have a length L_8 and platens 454 have a length L_9 that is longer than length L_8 . In an alternative embodiment, length L_8 that is longer than length L_9 . In another embodiment, length L_8 is substantially the same as length L_9 . In a further embodiment, platens 452 have differing lengths and/or platens 454 have differing lengths.

Moreover, platens 450 are configured to couple to a tube cage (shown in Figure 2) and extend substantially vertically through syngas cooler 100. Further, the Y-shaped configuration of platens 450 reduces an overall size of platens 450 to less than a size of known platens, and also increases the exposure of platens 450 to a flowpath of syngas cooler 100 in comparison to known syngas cooler platens.

During operation, a syngas stream discharged from the gasifier (shown in Figure 1) is channeled into the top of syngas cooler 100. The syngas flows along platens 450 to facilitate heating boiler feedwater flowing through platens 450 to produce steam. By its nature the syngas flowing through syngas cooler 100 is optically dense with particulate matter that limits radiation heat transfer to platens 450 due to limited sight pathways. Further, the particulate matter within the syngas stream may have a tendency to deposit on platens 450, thus reducing heat transfer. However, in the exemplary embodiment, the vertical orientation and the increased exposure of platens 450 to the flowpath of syngas facilitate reducing the deposition of solids from the syngas stream. As a result, heat transfer from the syngas stream to the boiler feedwater and steam production are facilitated to be increased. Moreover, the reduced size of platens 450 facilitates reducing an overall length and/or diameter of syngas cooler 100 without adversely affecting steam production and/or increasing the fabrication costs that are dependant on the size of syngas cooler 100.

Figure 10 is a further embodiment of a plurality of platens 500 that may be used with syngas cooler 100. Figure 11 is a top view of platens 500. Platens 500 are helical. Specifically, each platen 500 extends both vertically along centerline 104 and circumferentially about centerline 104. Further, each platen 500 extends length L_{10} outward from centerline 104 toward the wall or shell (shown in Figure 2) of syngas cooler 100. Moreover, each platen 500 overlaps an adjacent platen 500, such that the plurality of platens 500 form a helical-screw pattern.

Platens 500 are configured to couple to a tube cage (shown in Figure 2) and extend substantially vertically through syngas cooler 100. Further, the helical configuration of platens 500 reduces an overall size of platens 500 to less than a size of known platens, and also increases the exposure of platens 500 to a flowpath of syngas cooler 100 in comparison to known syngas cooler platens.

During operation, a syngas stream discharged from the gasifier (shown in Figure 1) is channeled into the top of syngas cooler 100. The syngas flows along platens 500 to facilitate heating boiler feedwater flowing through platens 500 to produce steam. By its nature the syngas flowing through syngas cooler 100 is optically dense with

particulate matter that limits radiation heat transfer to platens 500 due to limited sight pathways. Further, the particulate matter within the syngas stream may have a tendency to deposit on platens 500, thus reducing heat transfer. However, in the exemplary embodiment, the vertical orientation and the increased exposure of platens 500 to the flowpath of syngas facilitate reducing the deposition of solids from the syngas stream. As a result, heat transfer from the syngas stream to the boiler feedwater and steam production are facilitated to be increased. Moreover, the reduced size of platens 500 facilitates reducing an overall length and/or diameter of syngas cooler 100 without adversely affecting steam production and/or increasing the fabrication costs that are dependant on the size of syngas cooler 100.

Figure 12 is yet another embodiment of a plurality of platens 550 that may be used with syngas cooler 100. Platens 550 include a first portion of platens 552 and a second portion of platens 554. Specifically, platens 552 are configured essentially similar to platens 300 (shown in Figure 6), and platens 554 are configured essentially similar to platens 500 (shown in Figures 10 and 11).

Figure 13 is an alternative embodiment of a plurality of platens 600 that may be used with syngas cooler 100. Platens 600 include a first portion of platens 602 and a second portion of platens 604. Specifically, platens 602 are configured essentially similar to the embodiment of platens 300 shown in Figure 8, and platens 604 are configured essentially similar to the embodiment of platens 300 shown in Figure 7.

Although Figures 12 and 13 only illustrate combinations of the platens shown in Figures 6, 10, and 11, as will be appreciated by one of ordinary skill in the art, any of the platens shown in Figures 3-11 can be used in combination to form a plurality of platens that may be used with syngas cooler 100.

Specifically, any combination of the platens described herein will facilitate reducing the deposition of solids from the syngas stream, thereby increasing heat transfer from the syngas stream to the boiler feedwater and increasing steam production. Moreover, any combination of the platens described herein will facilitate reducing an overall

length and/or diameter of syngas cooler 100 while maintaining steam production and reducing costs that are dependant on the size of syngas cooler 100.

In one embodiment, a method for fabricating a syngas cooler is provided. The method includes coupling a tube cage within the syngas cooler, and coupling a plurality of platens to the tube cage to facilitate steam production in the syngas cooler. At least a first platen has at least one of a length that is larger than a length of a second platen, a non-linear geometry, and an angular position that is oblique with respect to a wall of the syngas cooler. In the exemplary embodiment, the method includes coupling the plurality of platens circumferentially around a centerline of the syngas cooler.

Further, in one embodiment, the method includes coupling a first platen at an angle with respect to a second platen. In another embodiment, the method includes fabricating at least one arcuate platen. In a further embodiment, the method includes fabricating at least one helical platen. Moreover, in the exemplary embodiment, the method includes fabricating at least one of the plurality of platens to with an increased surface area to facilitate improving steam production in the syngas cooler. In the exemplary embodiment, the method also includes fabricating at least one of the plurality of platens with a geometry that facilitates reducing an overall size of the syngas cooler.

The above-described systems and methods facilitate reducing an overall length and/or diameter of the syngas cooler while maintaining steam production and reducing costs that are dependant on the size of the syngas cooler. Specifically, during operation, a syngas stream is discharged from the gasifier into the top of a vertically oriented syngas cooler. The syngas then flows along the platens to heat boiler feedwater flowing through the platens, thereby producing steam. By its nature the syngas flowing through the syngas cooler is optically dense with particulate matter that limits radiation heat transfer to the platens due to limited sight pathways. Further, the particulate matter within the syngas stream may also deposit on the platens further reducing heat transfer.

Accordingly, the platens disclosed herein are oriented in a vertical fashion and spaced from the centerline of the syngas cooler to facilitate preventing deposition of solids from the syngas stream. Moreover, the platens described herein are configured to facilitate providing a greater exposure of the platen surface area to a flowpath of the syngas cooler in comparison to known syngas cooler platens. Specifically, the platens described herein are configured with geometric configurations, wherein a number, an angle, and a length of the platens differ from known syngas cooler platens. More specifically, the platens are configured with differing lengths and/or non-linear geometries and/or configured to couple to a tube cage at an oblique angle with respect to a wall of the syngas cooler.

By reducing the deposition of solids and increasing the surface area of the platens, the platens disclosed herein facilitate increasing heat transfer from the syngas stream to the boiler feedwater and, thus, increasing steam production. In addition, the platens described herein are configured to require less space within the syngas cooler. Accordingly, the platens facilitate reducing an overall length and/or diameter of the syngas cooler while maintaining steam production and reducing costs that are dependant on the size of the syngas cooler.

As used herein, an element or step recited in the singular and proceeded with the word "a" or "an" should be understood as not excluding plural said elements or steps, unless such exclusion is explicitly recited. Furthermore, references to "one embodiment" of the present invention are not intended to be interpreted as excluding the existence of additional embodiments that also incorporate the recited features.

Exemplary embodiments of systems and methods for fabricating syngas cooler platens are described above in detail. The systems and methods illustrated are not limited to the specific embodiments described herein, but rather, components of the system may be utilized independently and separately from other components described herein. Further, steps described in the method may be utilized independently and separately from other steps described herein.

While the invention has been described in terms of various specific embodiments, it will be recognized that the invention can be practiced with modification within the spirit and scope of the claims.

WHAT IS CLAIMED IS:

1. A method for fabricating a syngas cooler, said method comprising:

coupling a tube cage within a syngas cooler; and

coupling a plurality of platens to the tube cage to facilitate steam production in the syngas cooler, wherein at least a first platen has at least one of a length that is larger than a length of a second platen, a non-linear geometry, and an angular position that is oblique with respect to a wall of the syngas cooler.
2. A method in accordance with Claim 1 wherein coupling the plurality of platens to the tube cage further comprises coupling the plurality of platens circumferentially around an approximate centerline of the syngas cooler.
3. A method in accordance with Claim 1 wherein coupling the plurality of platens to the tube cage further comprises coupling a first platen at an angle with respect to a second platen.
4. A method in accordance with Claim 1 further comprising fabricating at least one arcuate platen.
5. A method in accordance with Claim 1 further comprising fabricating at least one helical platen.
6. A method in accordance with Claim 1 further comprising fabricating at least one of the plurality of platens with an increased surface area to facilitate improving steam production in the syngas cooler.
7. A method in accordance with Claim 1 further comprising fabricating at least one of the plurality of platens with a geometry that facilitates reducing an overall size of the syngas cooler.
8. A syngas cooler comprising:

a tube cage;

a plurality of platens coupled to the tube cage to facilitate steam production in the syngas cooler, wherein at least a first platen has at least one of a length that is larger than a length of a second platen, a non-linear geometry, and an angular position that is oblique with respect to a wall of the syngas cooler.

9. A syngas cooler in accordance with Claim 8 wherein the plurality of platens are circumferentially coupled around an approximate centerline of the syngas cooler.

10. A syngas cooler in accordance with Claim 8 wherein a first platen is coupled at an angle with respect to a second platen.

11. A syngas cooler in accordance with Claim 8 wherein at least one of the plurality of platens is arcuate.

12. A syngas cooler in accordance with Claim 8 wherein at least one of the plurality of platens is helical.

13. A syngas cooler in accordance with Claim 8 wherein at least one of said plurality of platens has an increased a surface area to facilitate improving steam production in the syngas cooler.

14. A syngas cooler in accordance with Claim 8 wherein at least one of said plurality of platens facilitates reducing an overall size of said syngas cooler.

15. A plurality of platens configured to coupled to a tube cage of a syngas cooler to facilitate steam production in the syngas cooler, wherein at least a first platen has at least one of a length that is larger than a length of a second platen, a non-linear geometry, and an angular position that is oblique with respect to a wall of the syngas cooler.

16. A platen in accordance with Claim 15 wherein said platen is coupled to the tube cage at an angle with respect to a second platen.

17. A platen in accordance with Claim 15 wherein said platen is arcuate.

18. A platen in accordance with Claim 15 wherein said platen is helical.

19. A platen in accordance with Claim 15 wherein said platen has an increased a surface area to facilitate improving steam production in the syngas cooler.
20. A platen in accordance with Claim 15 wherein said platen facilitates reducing an overall size of the syngas cooler.

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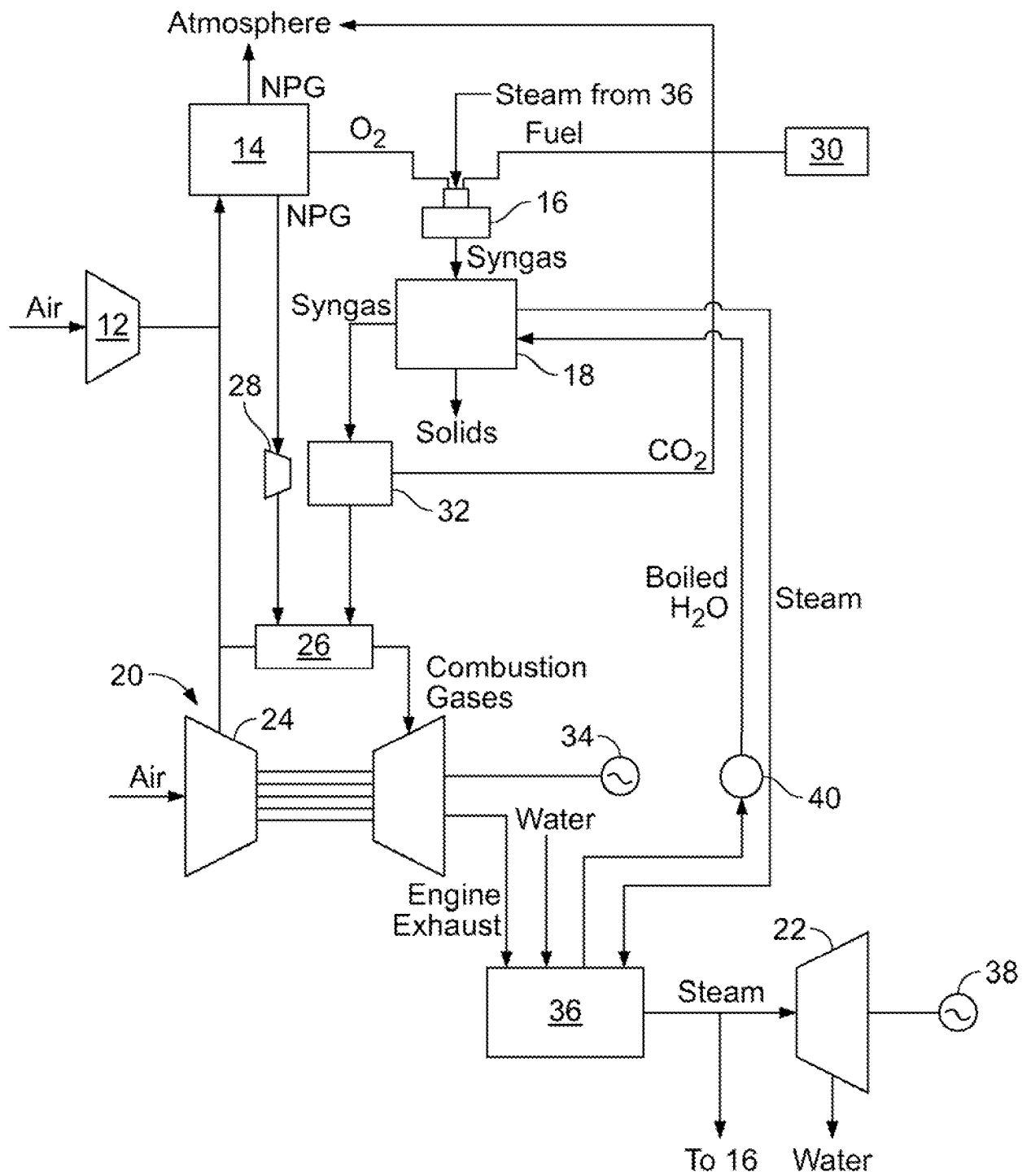


FIG. 1

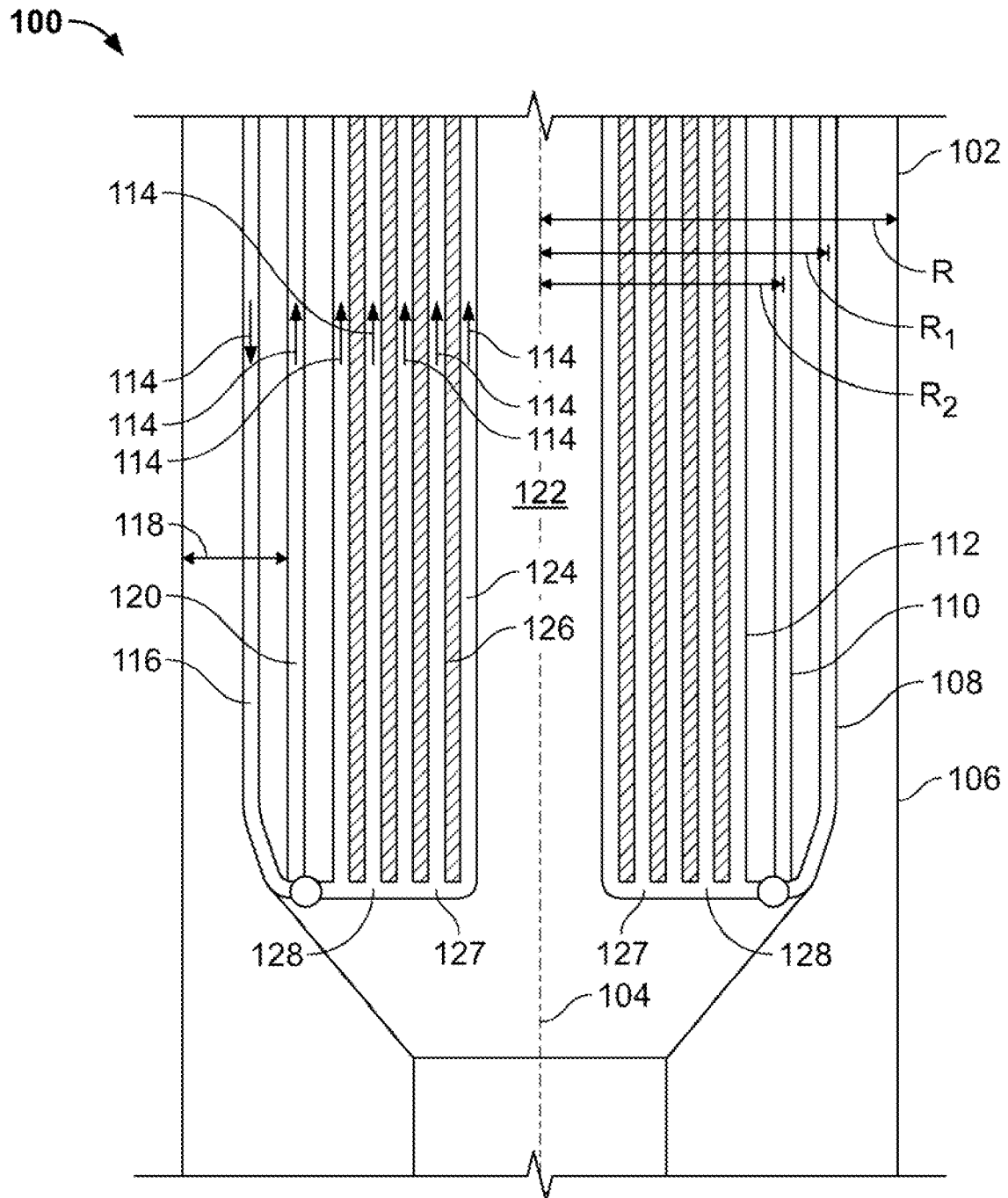
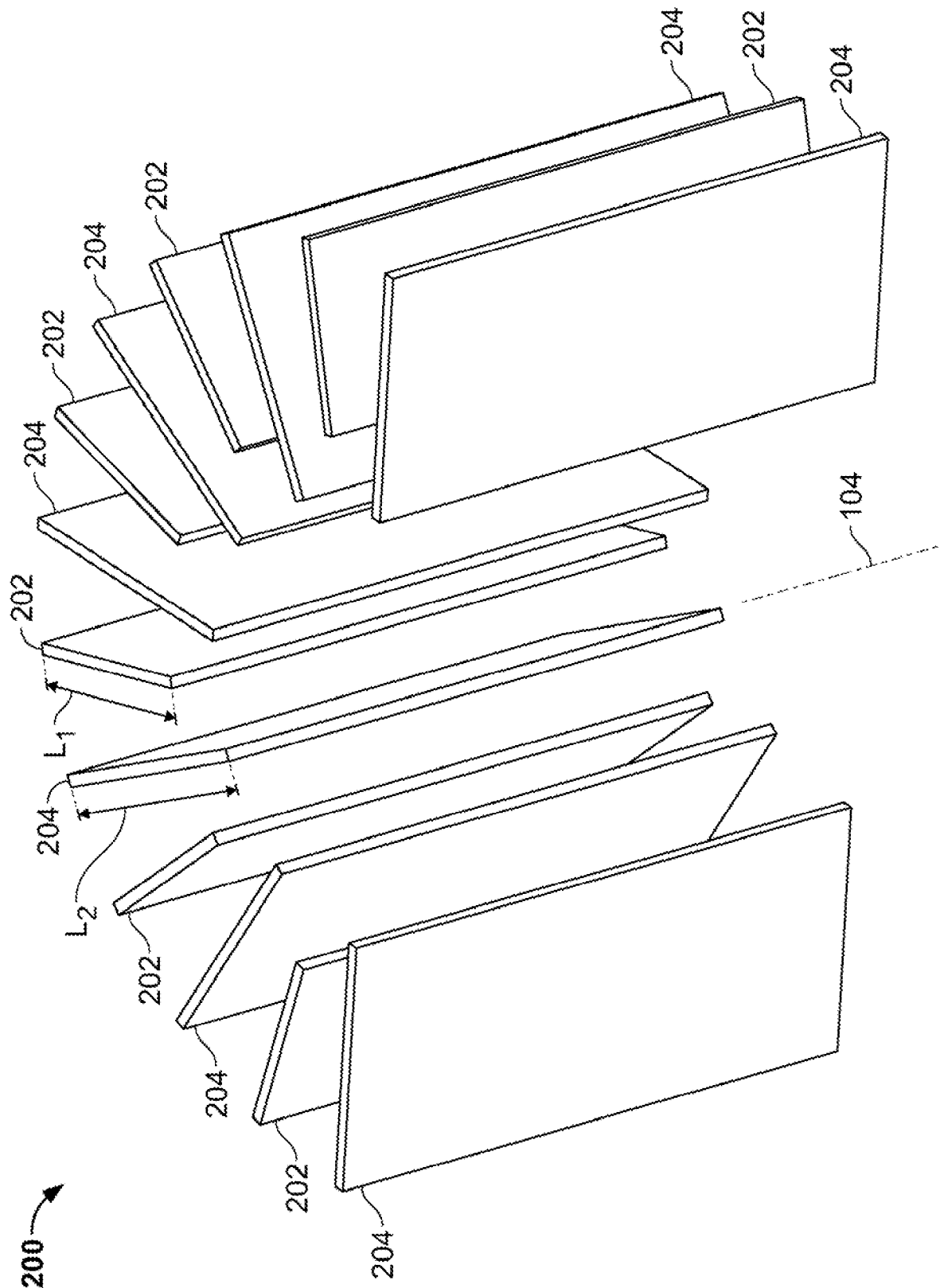


FIG. 2



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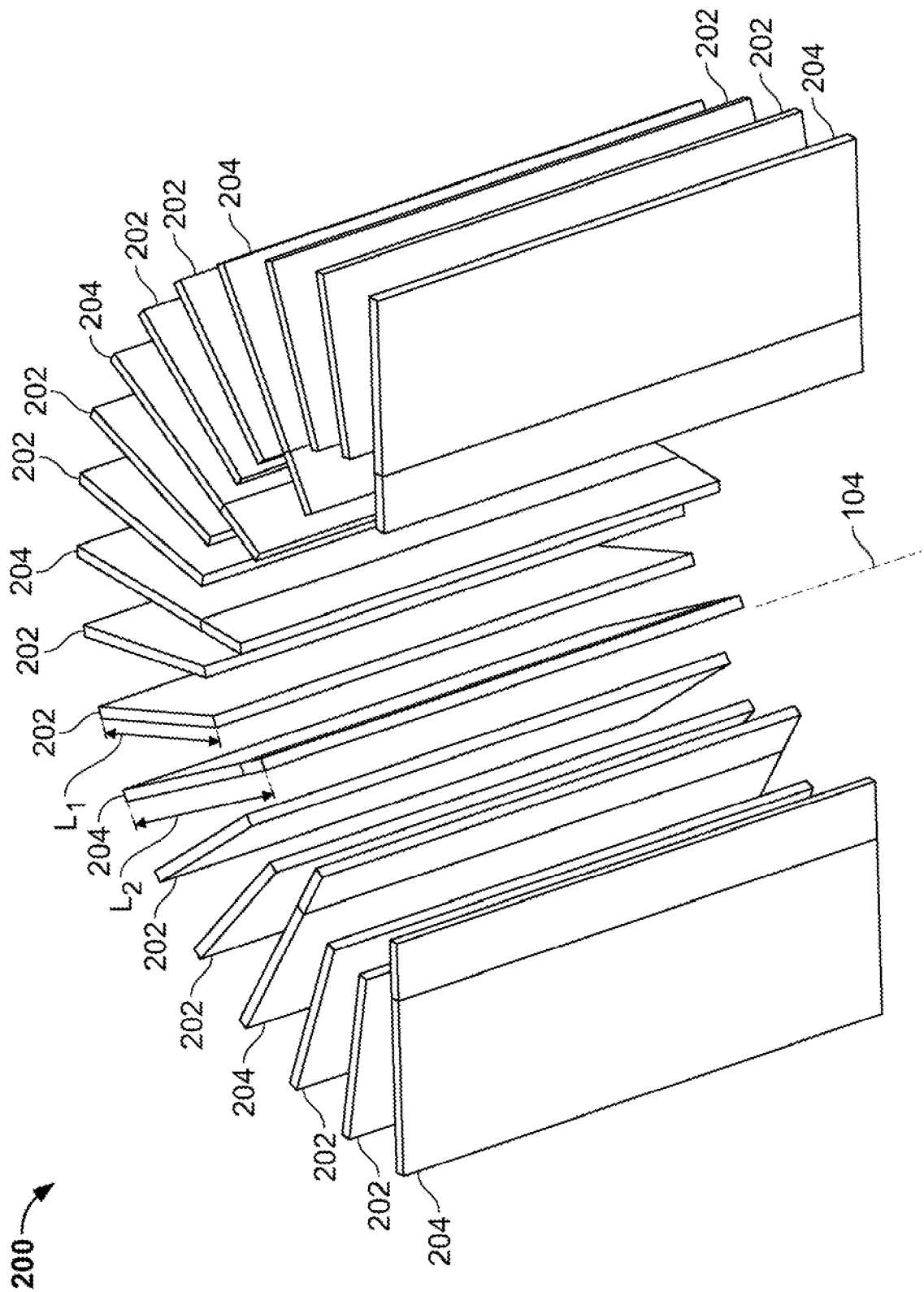


FIG. 4

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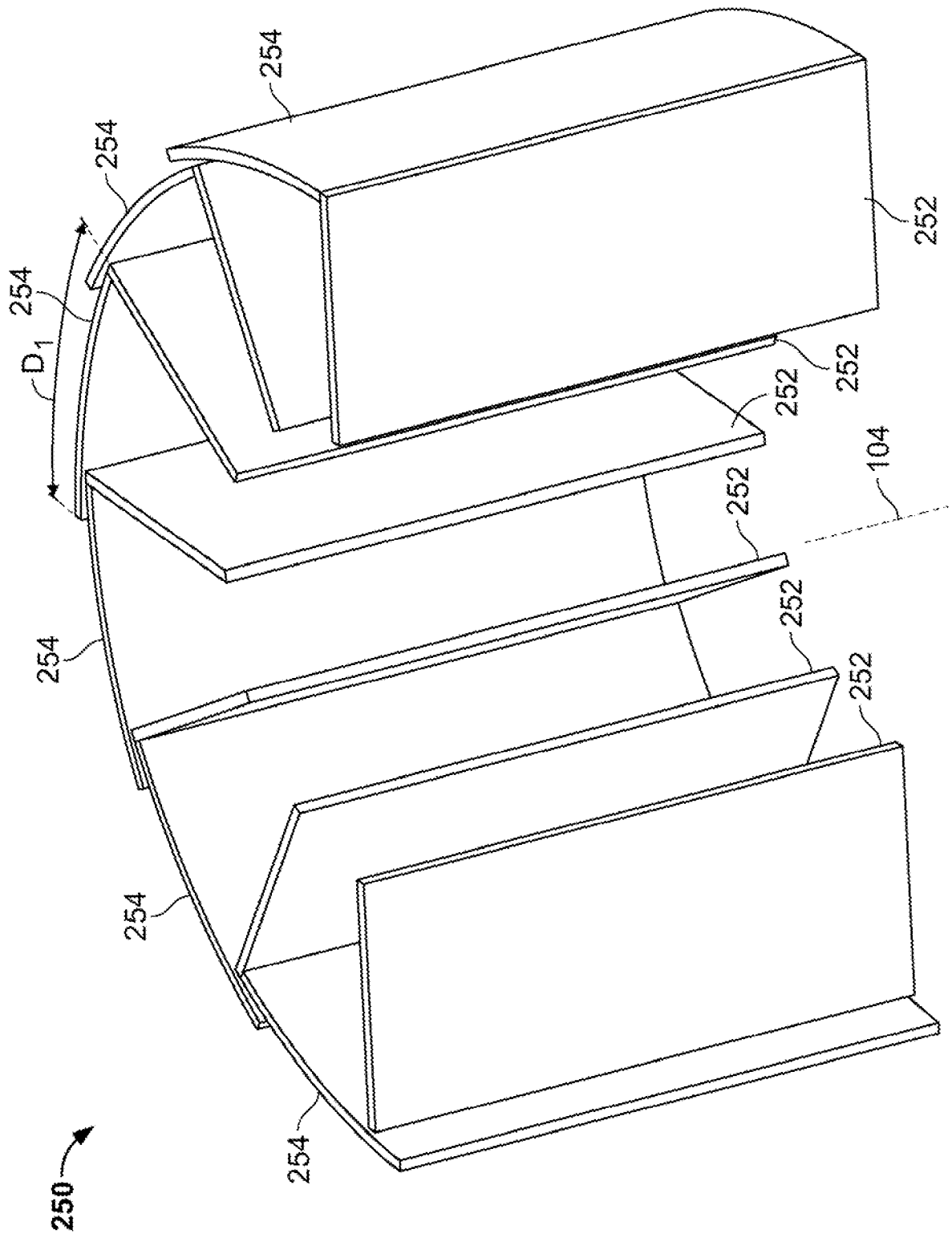


FIG. 5

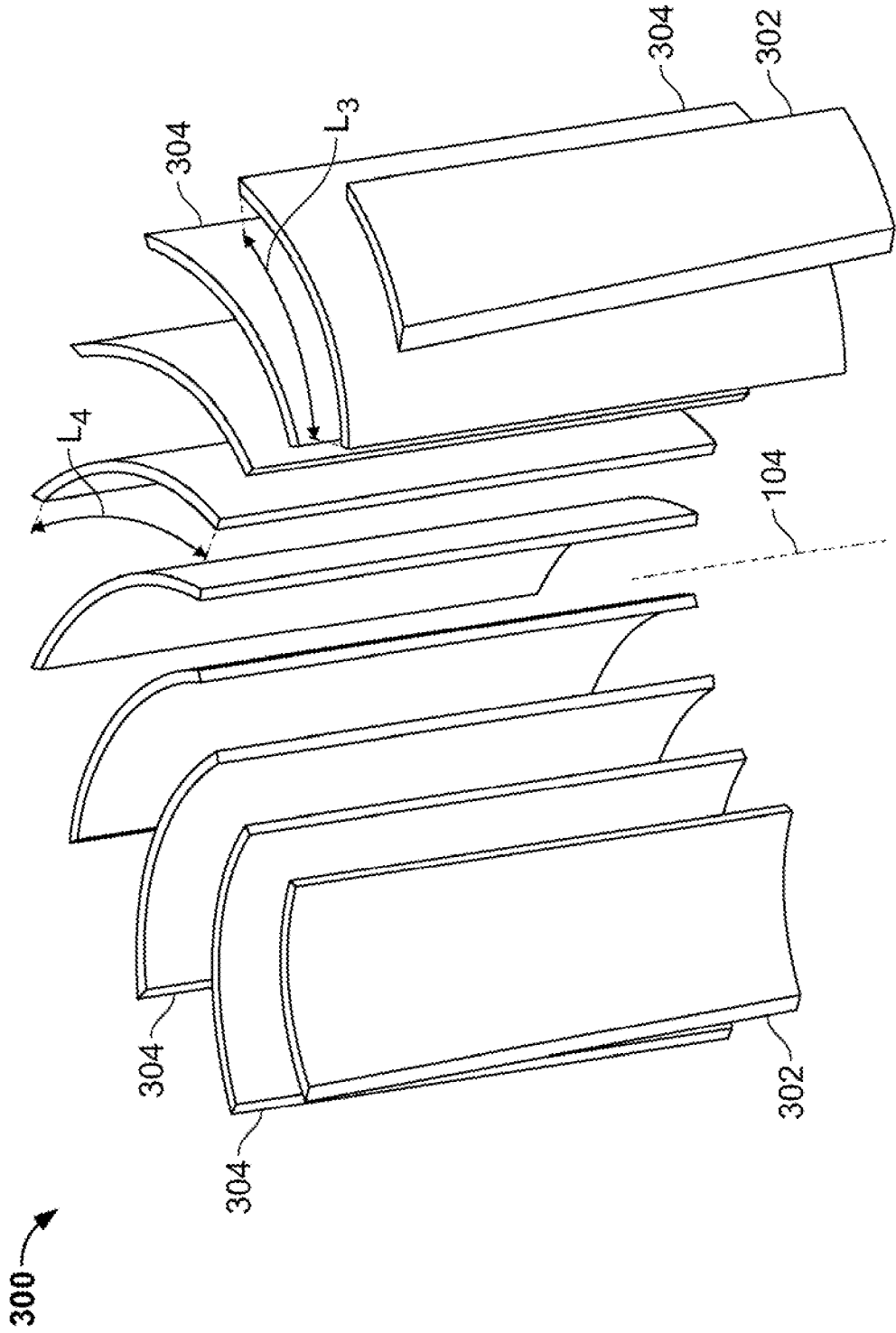


FIG. 6

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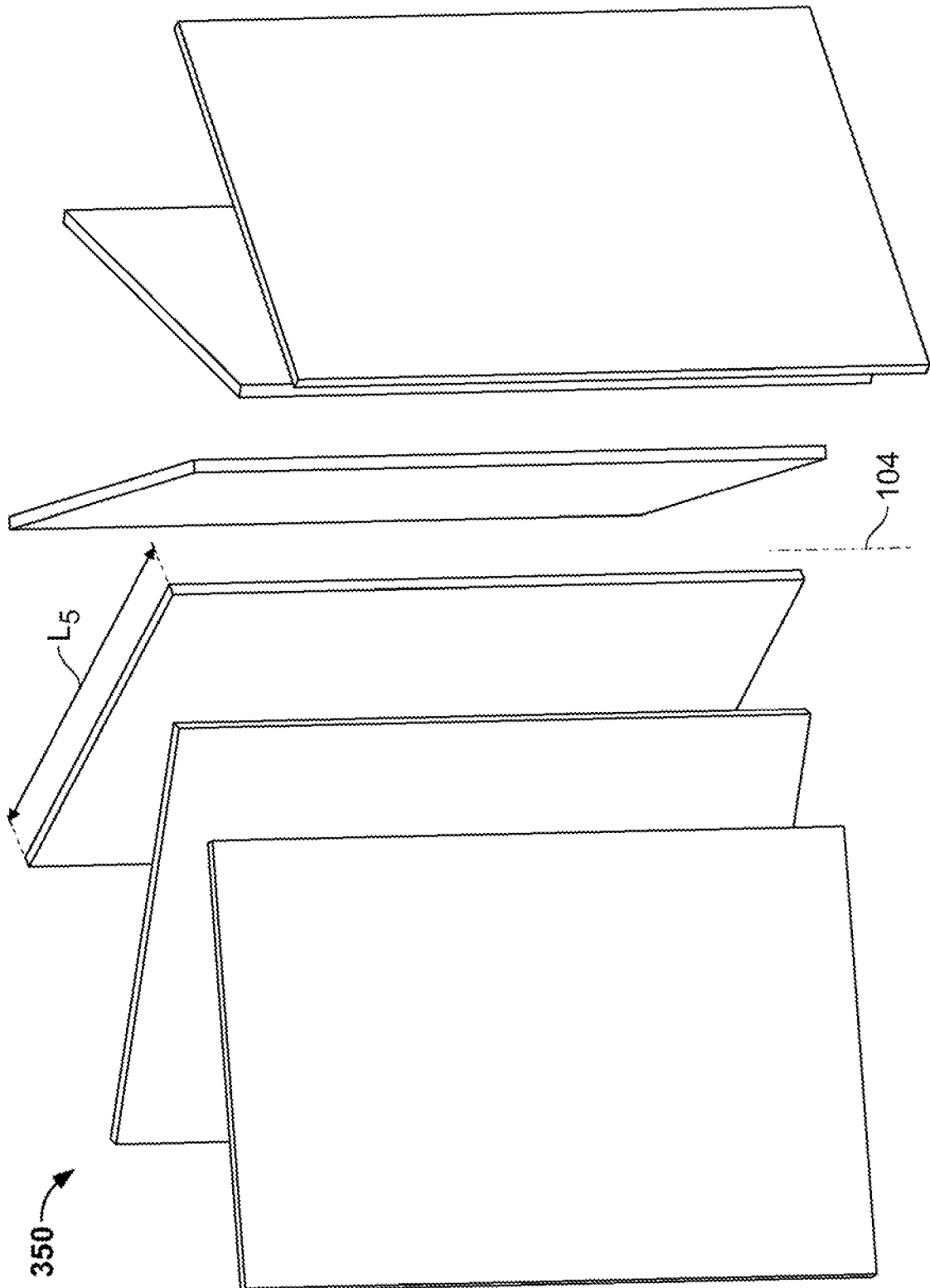


FIG. 7

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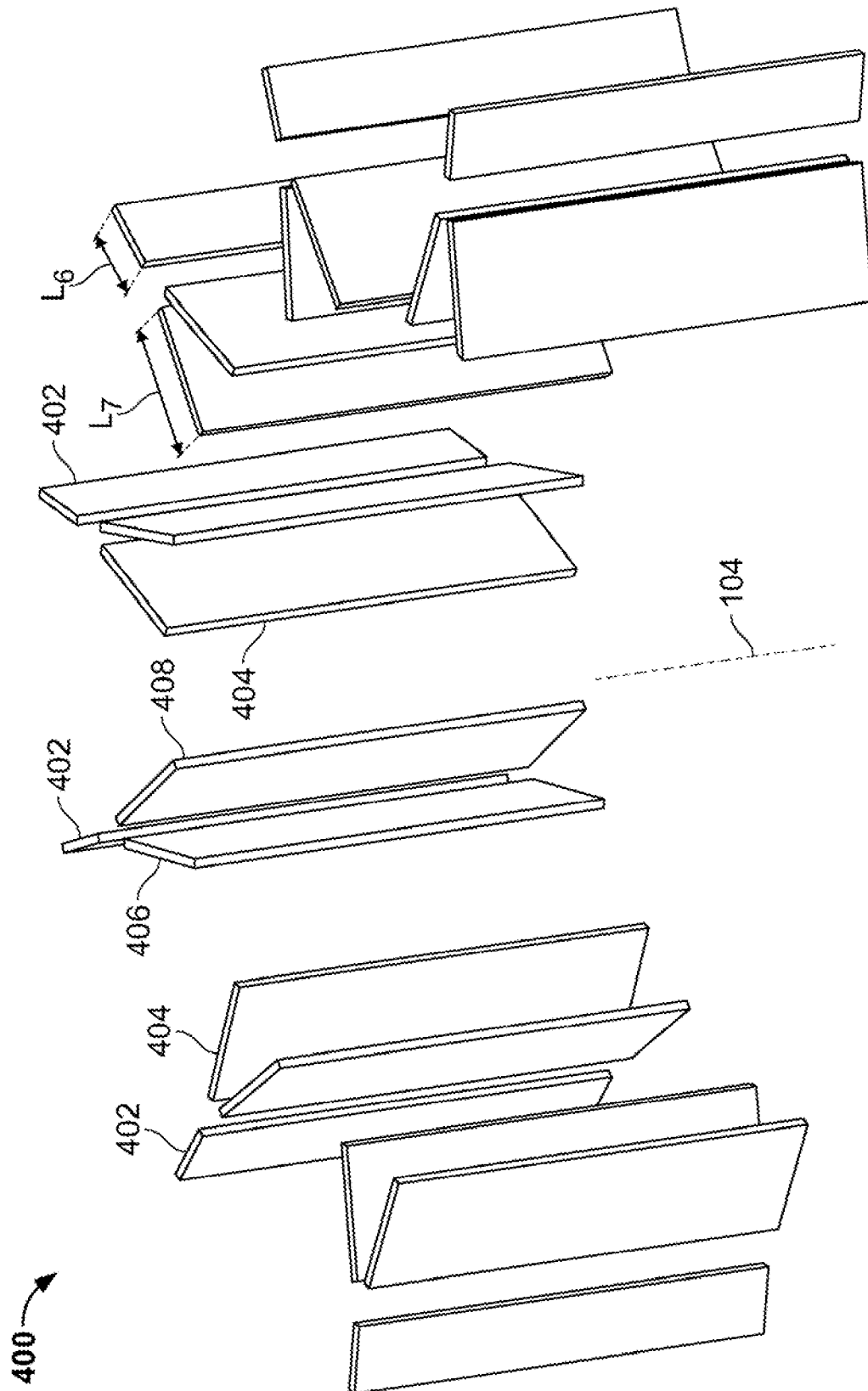


FIG. 8

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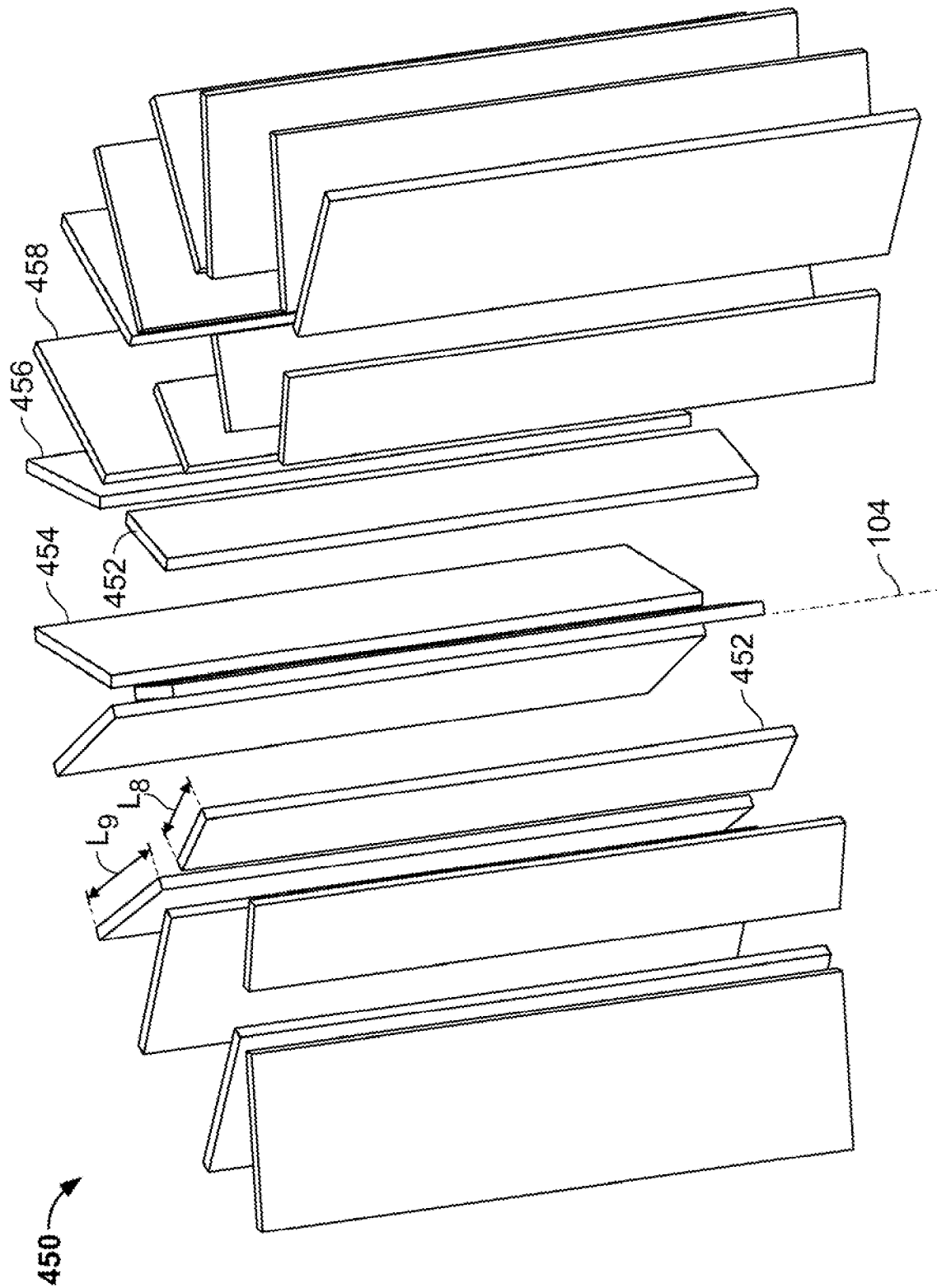


FIG. 9

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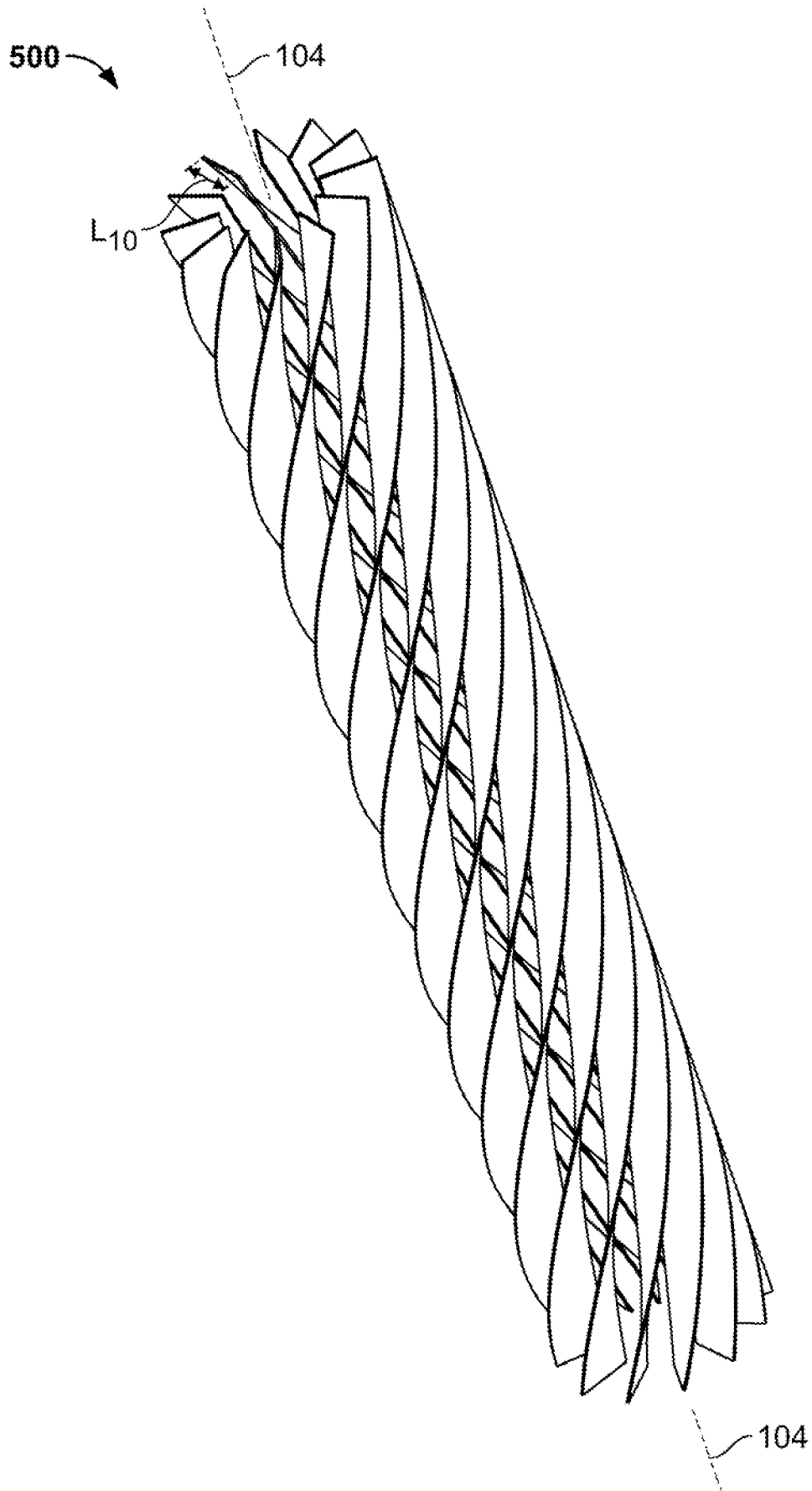


FIG. 10

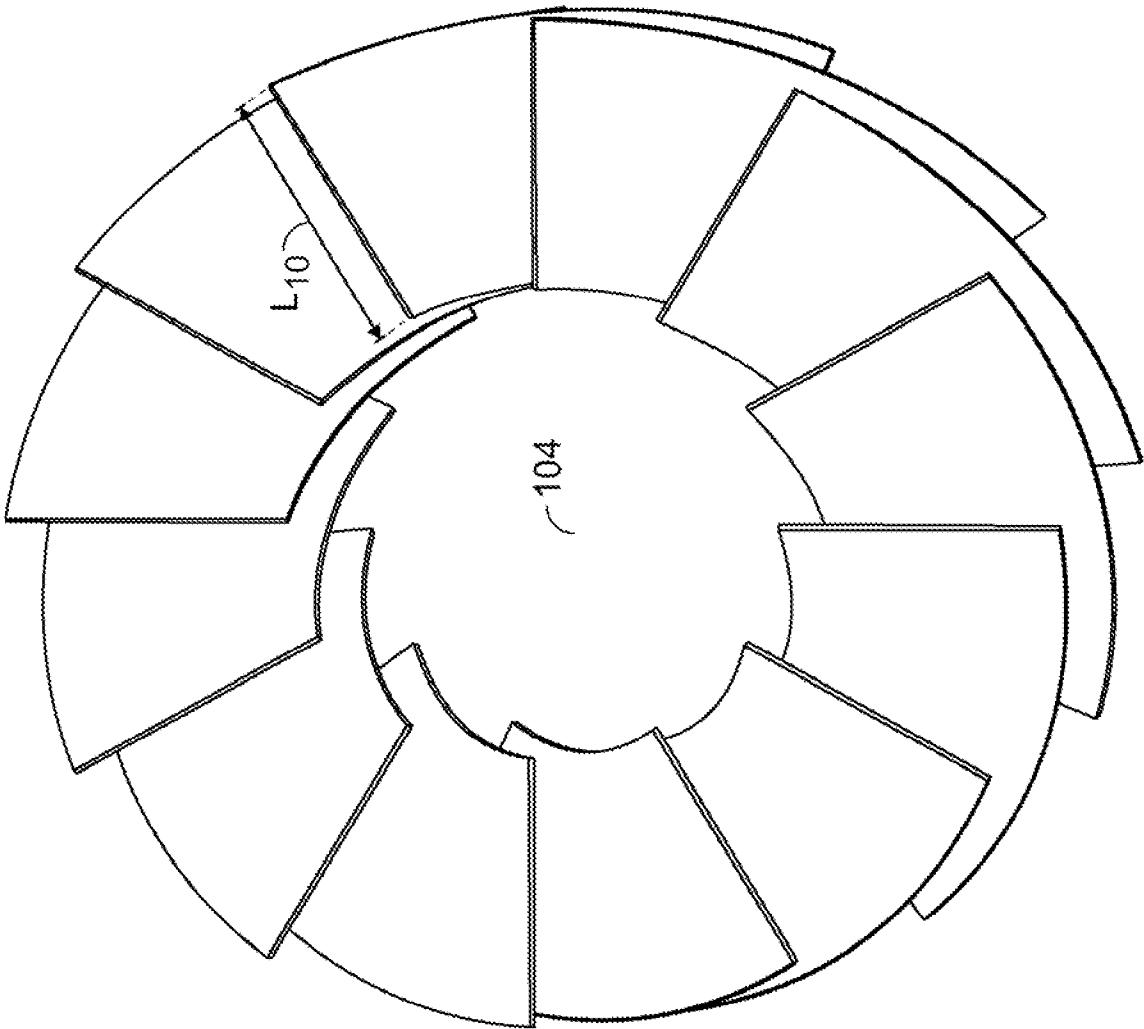


FIG. 11

500

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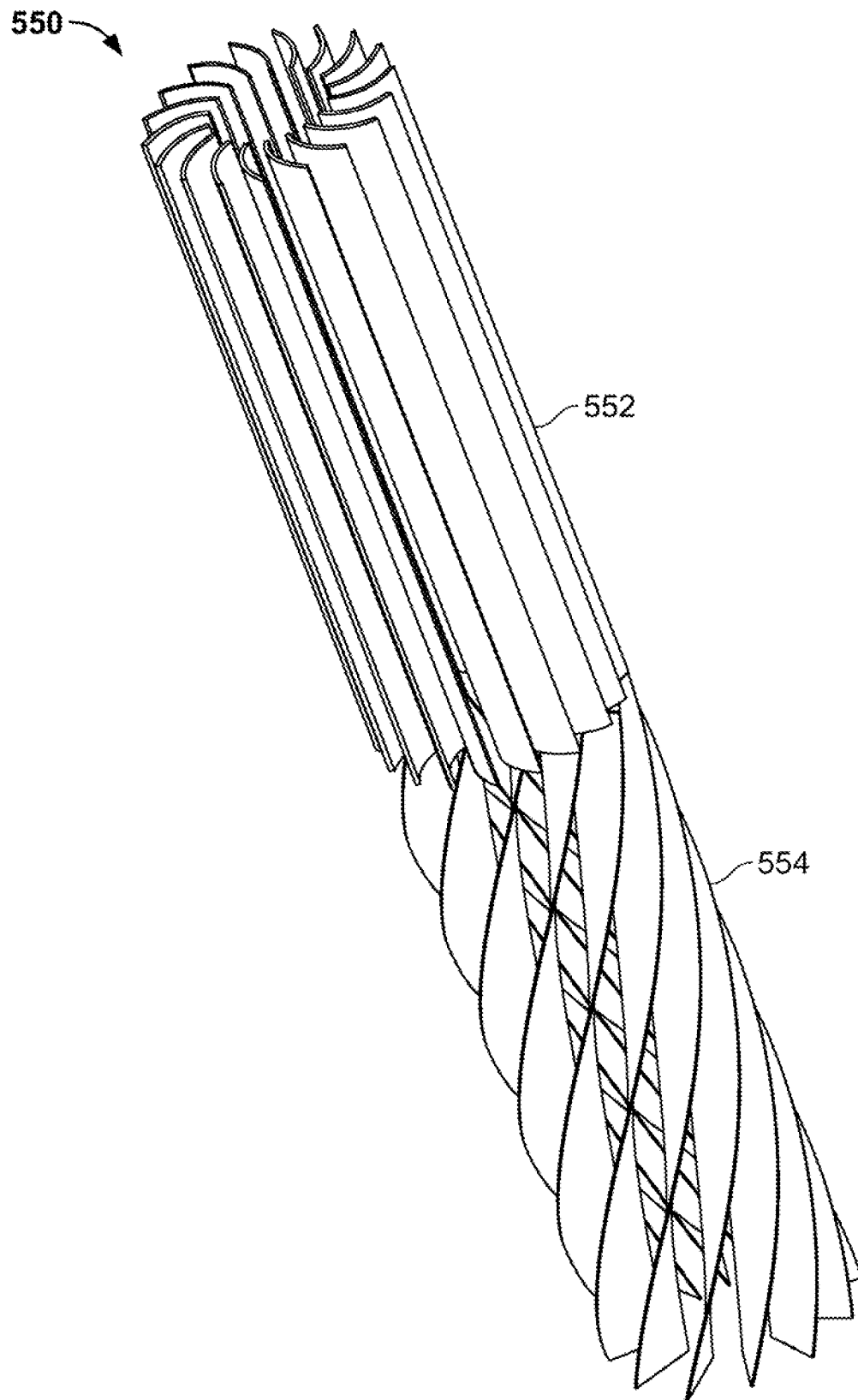


FIG. 12

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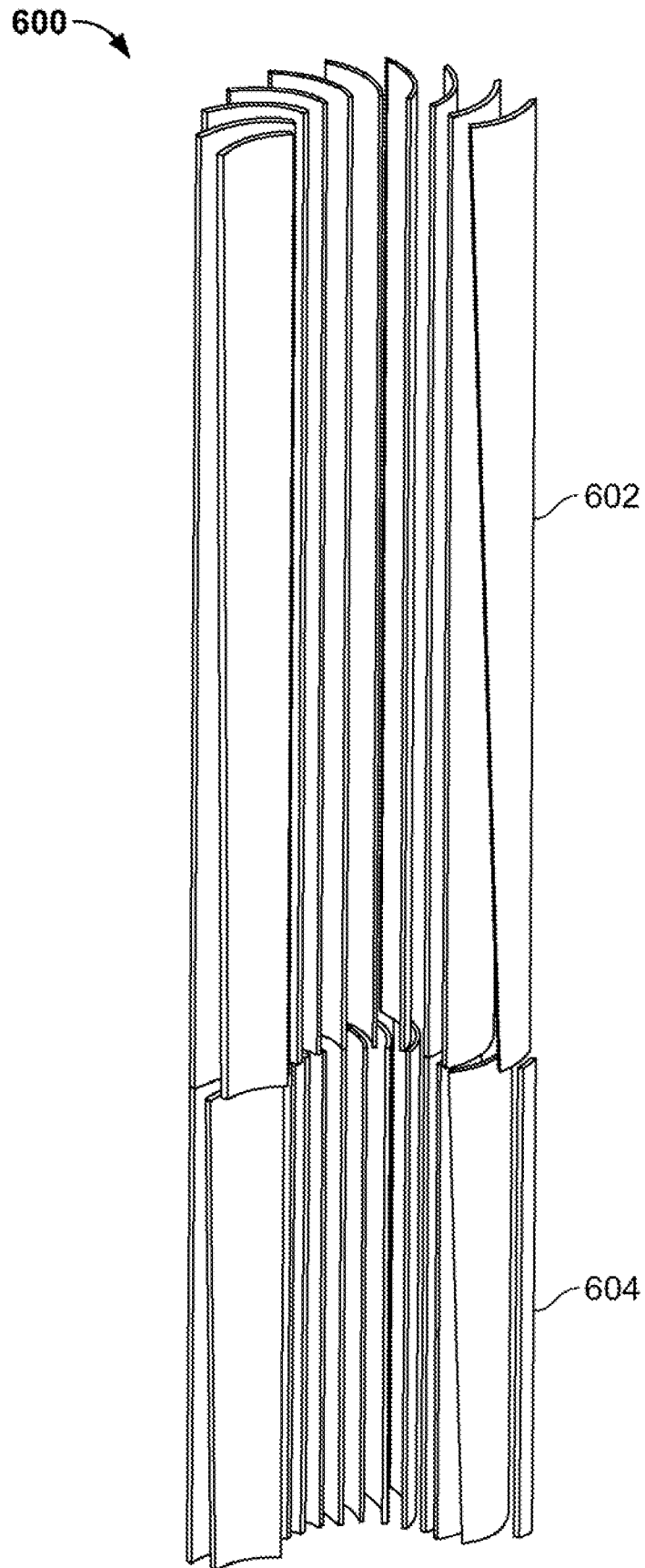


FIG. 13

INTERNATIONAL SEARCH REPORT

International application No

PCT/US2008/080458

A. CLASSIFICATION OF SUBJECT MATTER

INV. F28D7/16

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

F28D F22B C10J

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2007/055930 A (BABCOCK & WILCOX CO [US]) 18 May 2007 (2007-05-18) abstract; figures 7-9	1,3,6-8, 10, 13-16, 19,20
X	WO 2006/110087 A (HAWRANEK JERZY [SE]) 19 October 2006 (2006-10-19) figures 6c,6e	1,2,4,8, 9,11,15, 17
X	WO 91/10106 A (BURMEISTER & WAINS ENERGI [DK]) 11 July 1991 (1991-07-11) page 6, line 24-page 7, line 28; page 8, lines 33-36; figures 1-4 -/--	1;8,15



Further documents are listed in the continuation of Box C.



See patent family annex.

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Z document member of the same patent family

Date of the actual completion of the international search

22 January 2009

Date of mailing of the international search report

02/02/2009

Name and mailing address of the ISA/

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Authorized officer

Martínez Rico, Celia

INTERNATIONAL SEARCH REPORT

International application No

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C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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Information on patent family members

International application No

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