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(54) **Method and apparatus for radial exhaust gas turbine**

(57) An involute type casing apparatus for a gas turbine engine that includes a radial exhaust diffuser (112) is provided. The apparatus includes a turbine engagement wall (13) having an entry opening (14), an exhaust diffuser engagement wall (113) spaced a distance from said turbine engagement wall, said diffuser engagement wall comprising an engine shaft hole (118) sized and oriented to said radial exhaust diffuser, a plurality of substantially straight sidewalls (120) coupled to or adjacent to edges of said turbine engagement walls and to or adjacent to edges of said exhaust diffuser engagement wall,

and a plurality of substantially planar plates (22) coupled to or adjacent to other edges (420) of said turbine engagement wall and to or adjacent to other edges (320) of said exhaust diffuser engagement wall, such that said substantially planar plates approximate a portion of a cycle of an involute curve (700). The apparatus is configured to enclose the radial exhaust diffuser, and the top plate, bottom plate, substantially straight sidewalls, and substantially straight plates are engaged so that exhaust from the radial exhaust diffuser exits the apparatus via an outlet side.

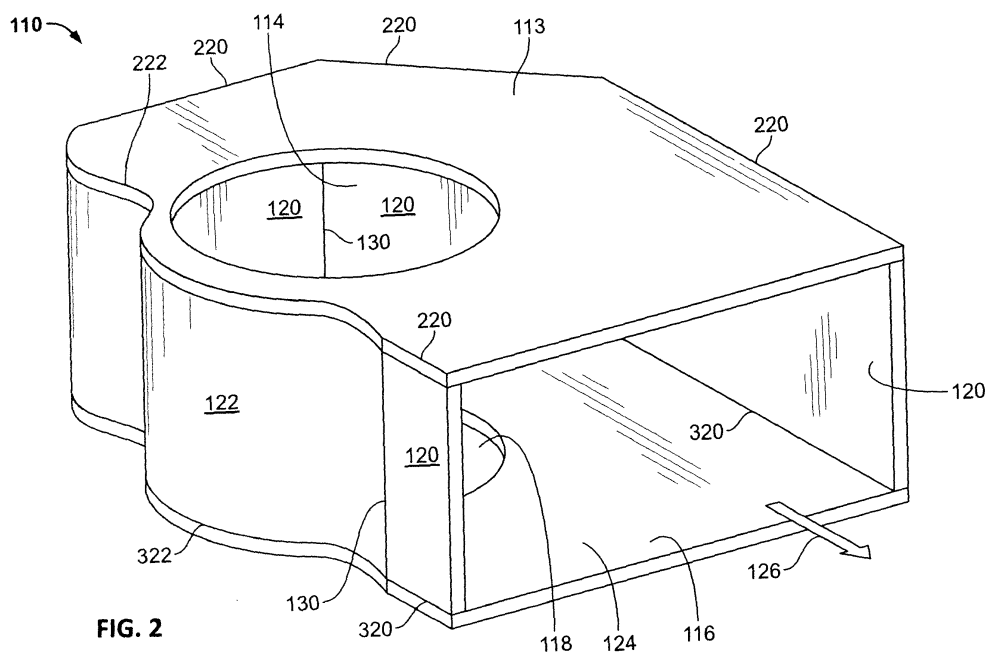


FIG. 2

Description

BACKGROUND OF THE INVENTION

[0001] The field of the present invention relates generally to gas turbine generators, and more specifically to involute type casings for use with radial exhaust gas turbines.

[0002] At least some known gas turbine engines may experience high pressure losses. Such pressure losses may adversely affect engine performance and/or engine efficiency. For example, at least some known radial exhaust gas turbines that include an outer casing may experience high pressure losses in their exhaust diffuser sections. Although circular outer casings can be used to reduce this pressure drop, such casings may be expensive to manufacture, especially for gas turbines that require large size casings.

[0003] It would therefore be desirable to provide a more efficient and less expensive casing for use with gas turbines that include a radial exhaust. In particular, it would be desirable to provide a casing that reduces pressure losses in the outer casing section while not being relatively expensive to manufacture. The reduced pressure losses may enable the gas turbine to provide additional power augmentation without using any additional fuel, thus increasing the operating efficiency of the turbine.

BRIEF DESCRIPTION OF THE INVENTION

[0004] In one aspect, an involute type casing apparatus for a gas turbine engine that includes a radial exhaust diffuser is provided. The apparatus includes a turbine engagement wall having an entry opening, and an exhaust diffuser engagement wall spaced a distance from the turbine engagement wall. The diffuser engagement wall has an engine shaft hole sized and oriented to the radial exhaust diffuser. The apparatus also includes a plurality of substantially straight sidewalls coupled to or adjacent to edges of the turbine engagement walls and to or adjacent to edges of the exhaust diffuser engagement wall, and a plurality of substantially planar plates coupled to or adjacent to other edges of the turbine engagement wall and to or adjacent to other edges of the exhaust diffuser engagement wall, such that the substantially planar plates approximate a portion of a cycle of an involute curve. The apparatus is configured to enclose the radial exhaust diffuser, and the top plate, bottom plate, substantially straight sidewalls, and substantially straight plates are engaged so that exhaust from the radial exhaust diffuser exits the apparatus via an outlet side.

[0005] In another aspect, a radial exhaust gas turbine apparatus is provided. The radial exhaust gas turbine apparatus has an inlet section, a compressor section operatively coupled to the inlet section, a combustor section operatively coupled to the compressor section, a turbine section operatively coupled to the combustor section, a

radial exhaust diffuser operatively coupled to the turbine section, and an involute type casing enclosing a radial exhaust diffuser. The involute type casing has a turbine engagement wall having an entry opening and an exhaust diffuser engagement wall spaced a distance from the turbine engagement wall, wherein the diffuser engagement wall includes an engine shaft hole sized and oriented to the radial exhaust diffuser. The involute type casing also has a plurality of substantially planar plates coupled to or adjacent to other edges of the turbine engagement wall and to or adjacent to other edges of the exhaust diffuser engagement wall, such that the substantially planar plates approximate a portion of a cycle of an involute curve. The involute type casing also has a plurality of substantially straight plates coupled to the turbine engagement wall such that the substantially straight plates are adjacent to outer edges of the exhaust diffuser engagement wall, approximating a portion of a cycle of an involute curve. The top plate, bottom plate, substantially straight walls, and substantially straight plates are engaged so that exhaust from the exhaust diffuser exits the involute type casing apparatus via an outlet side.

[0006] In still another aspect, a radial exhaust gas turbine apparatus is provided. The radial exhaust gas turbine apparatus has a gas turbine engine that includes a radial exhaust diffuser section and a casing apparatus consisting essentially of polygonal walls, substantially straight plates, and substantially straight sidewalls. The casing apparatus encloses the radial exhaust diffuser section and is configured to direct at least a substantial portion of the gas exiting the radial exhaust diffuser section to an exit in the casing apparatus via an approximately involute path.

[0007] It will thus be understood that embodiments of involute type casings are formed by joining different straight sections of metal sheets. The arrangement when installed on the radial exhaust gas turbine will reduce the pressure loss in the casing without increasing the cost of manufacturing the casing. The casing will collect the flue gas coming out from vanes and direct the flue gas towards one side. The involute type casing can be manufactured in right handed embodiments or left handed embodiments based upon engineering and installation requirements.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008]

Fig. 1 is a cut-away view of an exemplary gas turbine engine.

Fig. 2 is an oblique triaxial view of an exemplary casing for use with a radial exhaust diffuser.

Fig. 3 is an oblique triaxial exploded view of the casing shown in Fig. 2.

Fig. 4 is an oblique triaxial view of an exemplary casing that may be used with a radial exhaust diffuser of a gas turbine engine.

Fig. 5 is an oblique triaxial view of the casing shown in Fig. 4.

Fig. 6 is a flow chart of an exemplary method for making an involute casing.

Fig. 7 is a diagram illustrating an involute curve.

DETAILED DESCRIPTION OF THE INVENTION

[0009] Embodiments of the present disclosure include an involute type casing for use with a radial exhaust diffuser of a gas turbine generator. The radial exhaust diffuser, when installed on the radial exhaust gas turbine facilitates reducing pressure loss in the casing generally, without increasing costs of manufacturing the casing. Flue gas discharged from vanes enters the casing and is directed towards one side of the casing.

[0010] In some embodiments, and referring specifically to Fig. 1, a radial exhaust gas turbine 100 includes an inlet section 102, a compressor section 104, a combustor section 106, a turbine section 108, and an exhaust diffuser section 112. Fig. 2 and Fig. 3 illustrate respective triaxial and exploded triaxial views, respectively, of exhaust diffuser casing 110. In the illustrated embodiment, exhaust diffuser casing 110 includes a turbine engagement wall 113 that includes an entry opening 114. An exhaust diffuser engagement wall 116 is positioned opposite turbine engagement wall 113 and includes a hole 118 configured to permit the passing through of an engine shaft and opposite round entry opening 114. Entry opening 114 is in fluid communication with exhaust diffuser section 112, as is seen in Fig. 1, and need not be the same size as engine shaft hole 118. More specifically, engine shaft hole 118 may be any size relative to entry opening 114. A plurality of substantially straight sidewalls 120 and an arcuate wall 122 are welded or bolted, onto or adjacent to, edges 220 and 222 of turbine engagement wall 113 and to edges 320 and 322 of diffuser engagement wall 116. As a result, engagement walls 113 and 116 are maintained a fixed distance apart. Edges 130 of walls 120 and of wall 122 are also securely coupled together where they contact. An exhaust side 124 of exhaust diffuser casing 110 remains open and unobstructed to enable exhaust gas 126 to discharge into the atmosphere or into any other component.

[0011] Figs. 4 and 5 illustrate triaxial oblique views of an exhaust diffuser casing 10. In the exemplary embodiment, casing 10 includes a turbine engagement wall 13 including a substantially circular entry opening 14. An exhaust diffuser engagement wall 16 is positioned opposite to turbine engagement wall 13 and includes an engine shaft opening 18 formed opposite entry opening 14. Entry opening 14 is in fluid communication with exhaust

diffuser section 112, as best illustrated in Fig. 1, and may, but need not be, the same size as engine shaft opening 18. A plurality of substantially straight sidewalls 20 are coupled to or adjacent to edges 420 of turbine engagement wall 13 and to edges 520 of diffuser engagement wall 16. As such, walls 13 and 16 are maintained at a fixed distance apart. A plurality of substantially straight (planar) plates 22 of varying widths are coupled to or adjacent to edges 422 of turbine engagement wall 13 or to edges 522, such that walls 13 and 16 are substantially parallel to each other. In addition, sidewalls 20 are coupled to plates 22 where they contact, and where plates 22 meet one another. An exhaust side 224 of exhaust diffuser casing 10 remains open and unobstructed to enable exhaust gas 126 to be discharged to the atmosphere or into any other component.

[0012] In the exemplary embodiment, involute casing 10 is not arcuate, but rather, the same involute curve is approximated by wall edges 422 and 522. Involute casing 10 is shaped to channel the exhaust flow therethrough in a manner that facilitates reducing pressure drop in diffuser section 112. Moreover, the manufacture of involute casing 10 is no more expensive than that of current chambers. A length 722 (shown in Fig. 4) of each plate 22 is varied as necessary to obtain the desired involute casing profile. In addition, involute casing 10 may be assembled and used in either a right hand configuration or a left handed configuration. It should be noted that Figs. 2 and 3 illustrate a right handed prior art configuration, while Figs. 4 and 5 illustrate a left handed configuration.

[0013] The involute of a circle around the Z-axis in cylindrical coordinates (r, θ, z) is given by parametric equations written $r = a \sec \alpha$, $\theta = \tan \alpha - \alpha$, $z = z_0$, wherein a represents a radius of the circle, α is a parameter, and z_0 is a location of the circle along the Z-axis. As illustrated in Fig. 7, lengths 722 of each plate 22 are approximated by the lengths of line segments 752 defined along the involute. In some embodiments, line segments 752 are selected by the intersection of regularly or irregularly spaced angles in the θ -direction with the involute. A number of plates 22 should be between 3 and about 12 inclusive, to facilitate optimizing the time and cost of manufacturing. In the exemplary embodiment shown in Figs. 4 and 5, eight straight plates 22 are shown. To ensure a minimal effectiveness, at least 120° , but no more than 210° , of a cycle of an involute curve should be approximated. For the purposes of the claims recited below, each range recited above is considered to include all subranges. For example, an apparatus having between five and seven plates and that approximates between 160° and 210° of an involute cycle, is considered to be defined by the wider ranges recited above.

[0014] Plates 22 may include sheets fabricated from any suitable metallic material and may be either bolted or welded together in such a manner that eliminates the need to form (i.e., roll) the sheets into a curved contour.

[0015] In another aspect and referring to Figs. 4, 5, and 6, in some embodiments of the present invention,

an exemplary method 600 for making an involute type casing 10 for a radial exhaust gas turbine 100 is provided. In the exemplary embodiment, method 600 includes, fabricating 602 a polygonal first wall 13 that includes an opening 14 that is sized and oriented to engage a turbine section 108 of radial exhaust gas turbine 100. First wall 13 also includes a first set of at least three edges 422 that approximate between 120° and 210° of a cycle of an involute curve 700 illustrated in Fig. 7. First wall 13 also includes a second set of other substantially straight edges 420.

[0016] In the exemplary embodiment, method 600 also includes fabricating 604 a polygonal second wall 16 that includes an engine shaft opening 18 therein that is sized and oriented to engage a radial exhaust gas diffuser section 112. Second wall 16 includes a third set of at least three edges 520 used to approximate the same involute curve 700 as the first set of at least three edges 422 of first wall 13. Second wall 16 also includes a fourth set of straight edges 520 that each have approximately the same length as a corresponding edge 520 of the second set of edges 420.

[0017] Method 600 also includes fabricating 606 a plurality of plates 22. Specifically, the number of plates 22 fabricated 606 is equal to the number of edges in the first set of edges 422. Each plate 22 has a length 722 that is approximately the same size as a length 822 of a different edge 422, and all plates 22 are fabricated with the same width 922.

[0018] In the exemplary method 600, a plurality of sidewalls 20 are also fabricated 608. More specifically, the number sidewalls 20 is one less in number than the second set of edges 420. Each sidewall 20 has a width 720 that is approximately equal to the length 820 of a different edge 420, and a length 920 equal to the width 922 of plates 22.

[0019] Method 600 also includes affixing 610 each plate 22 at, or adjacent to, an edge 422 having the same length 822 as the length 722 of the affixed plate 22, and at, or adjacent to, an edge 522 having the same length 1022 as the width 922 of the affixed plate 22.

[0020] In the exemplary embodiment, method 600 also includes affixing 612 each sidewall 20 to first wall 13 and to second wall 16 between an edge 420 and an edge 520 having the same length as the width of the affixed sidewall 20. After completion of steps 602, 604, 606, 608, 610, and 612, a casing 10 such as that illustrated in Fig. 4 and Fig. 5 will be produced.

[0021] In the exemplary embodiment, method 600 can also include affixing adjacent plates 22, adjacent sidewalls 20, and plates 22 adjacent to straight sidewalls 20. Thus, in this embodiment, first wall 13 and second wall 16 are parallel to one another, outlet side 224 remains open, and all adjacent edges belonging to separate structure parts will be affixed to one another.

[0022] In some exemplary methods 600, first wall 13, second wall 16, each sidewall 20 and each straight plate 22 comprise fabricated sheet metal. The fabricated sheet

metal is cut or punched into predetermined shapes. Additionally, each affixing can include weld(s), bolt(s), and/or screw(s), in any combination.

[0023] Also in some exemplary method 600, between four and twelve plates 22, inclusive, are fabricated, or between six and ten plates 22, inclusive, are fabricated, or exactly eight plates 22 are fabricated. Referring to Fig. 7, each plate 22 has a dimension 752 approximating a portion 750 of an involute 754 of a circle 756. It is sufficient for involute casing 10 to be configured to enclose a radial gas diffuser section 112 of a radial exhaust gas turbine 100 and for the approximation of the portion 750 of involute 754 of circle 756 to guide at least a substantial portion of the gas exiting radial exhaust gas diffuser section 112 to an exit 224 in the casing apparatus via an approximately involute path.

[0024] It will thus be understood that an embodiment of involute type casing is formed by joining different straight sections of metal sheets. The arrangement when installed on the radial exhaust gas turbine will reduce the pressure loss in the casing without increasing the cost of manufacturing the casing. The casing will collect the flue gas coming out from vanes and direct the flue gas towards one side. The involute type casing can be manufactured in right handed embodiments or left handed embodiments based upon engineering and installation requirements.

[0025] In this written description, it should be understood that the phrase "equal to," when used in the context of dimensionality, refers to quantities equal to each other to within standard tolerances of good engineering practice. Similarly, the verb phrase "to approximate" refers to an approximation made within standard tolerances of good engineering practices and any other limitations imposed, such as requiring a curve to be approximated by a series of straight lines.

[0026] This written description uses examples to disclose the invention, including the best mode, and also to enable any person skilled in the art to practice the invention, including making and using any devices or systems and performing any incorporated methods. The patentable scope of the invention is defined by the claims, and may include other examples that occur to those skilled in the art. Such other examples are intended to be within the scope of the claims if they have structural elements that do not differ from the literal language of the claims, or if they include equivalent structural elements with insubstantial differences from the literal languages of the claims.

[0027] For completeness, various aspects of the invention are now set out in the following numbered clauses:

1. An involute type casing apparatus for a gas turbine engine that includes a radial exhaust diffuser, said apparatus comprising:

a turbine engagement wall having an entry

- opening;
- an exhaust diffuser engagement wall spaced a distance from said turbine engagement wall, said diffuser engagement wall comprising an engine shaft hole sized and
- oriented to said radial exhaust diffuser;
- a plurality of substantially straight sidewalls coupled to or adjacent to edges of said turbine engagement walls and to or adjacent to edges of said exhaust diffuser engagement wall; and
- a plurality of substantially planar plates coupled to or adjacent to other edges of said turbine engagement wall and to or adjacent to other edges of said exhaust diffuser engagement wall, such that said substantially planar plates approximate a portion of a cycle of an involute curve;
- said apparatus configured to enclose the radial exhaust diffuser; and the top plate,
- bottom plate, substantially straight sidewalls, and substantially straight plates are engaged so that exhaust from the radial exhaust diffuser exits the apparatus via an outlet side.
2. The apparatus of clause 1 wherein the top plate, bottom plate, substantially straight sidewalls, and substantially straight plates are engaged by welds.
3. The apparatus of clause 1 wherein the top plate, bottom plate, substantially straight sidewalls, and substantially straight plates are engaged by bolts.
4. The apparatus of clause 1 having at least 4 but not more than 12 substantially straight plates.
5. The apparatus of clause 1 having at least 6 but not more than 10 substantially straight plates.
6. The apparatus of clause 1 having 8 substantially straight plates.
7. A radial exhaust gas turbine apparatus comprising:
- an inlet section;
- a compressor section operatively coupled to the inlet section;
- a combustor section operatively coupled to the compressor section;
- a turbine section operatively coupled to the combustor section;
- a radial exhaust diffuser operatively coupled to the turbine section; and
- an involute type casing enclosing a radial exhaust diffuser,
- wherein the involute type casing further comprises:
- a turbine engagement wall having an entry opening;
- an exhaust diffuser engagement wall spaced a distance from said turbine engagement wall, said diffuser engagement wall comprising an engine shaft hole sized and
- oriented to said radial exhaust diffuser;
- a plurality of substantially planar plates coupled to or adjacent to other edges of said turbine engagement wall and to or adjacent to other edges of said exhaust diffuser engagement wall, such that said substantially planar plates approximate a portion of a cycle of an involute curve; and
- a plurality of substantially straight plates coupled to said turbine engagement wall such that said substantially straight plates are adjacent to outer edges of said exhaust diffuser engagement wall, approximating a portion of a cycle of an involute curve;
- wherein the top plate, bottom plate, substantially straight walls, and substantially straight plates are engaged so that exhaust from the exhaust diffuser exits the involute type casing apparatus via an outlet side.
8. The apparatus of clause 7 wherein the top plate, bottom plate, substantially straight walls, and substantially straight plates are engaged by welds.
9. The apparatus of clause 7 wherein the top plate, bottom plate, substantially straight walls, and substantially straight plates are engaged by bolts.
10. The apparatus of clause 7 having at least 4 but not more than 12 substantially straight plates.
11. The apparatus of clause 7 having at least 6 but not more than 10 substantially straight plates.
12. The apparatus of clause 7 having 8 substantially straight plates.

13. A radial exhaust gas turbine apparatus comprising:

gas turbine engine that includes a radial exhaust diffuser section; and

a casing apparatus consisting essentially of polygonal walls, substantially straight plates, and substantially straight sidewalls;

said casing apparatus enclosing the radial exhaust diffuser section and configured to direct at least a substantial portion of the gas exiting the radial exhaust diffuser section to an exit in the casing apparatus via an approximately involute path.

14. The apparatus of clause 13 wherein the polygonal walls, substantially straight plates, and substantially straight sidewalls are secured by welds.

15. The apparatus of clause 13 wherein the polygonal walls, substantially straight plates, and substantially straight sidewalls are secured by bolts.

16. The apparatus of clause 13 having at least 4 but not more than 12 substantially straight plates.

17. The apparatus of clause 13 having at least 6 but not more than 10 substantially straight plates.

18. The apparatus of clause 13 having 8 substantially straight plates.

Claims

1. An involute type casing apparatus for a gas turbine engine that includes a radial exhaust diffuser (112), said apparatus comprising:

a turbine engagement wall (13) having an entry opening (14);

an exhaust diffuser engagement wall (113) spaced a distance from said turbine engagement wall, said diffuser engagement wall comprising an engine shaft hole (118) sized and oriented to said radial exhaust diffuser;

a plurality of substantially straight sidewalls (120) coupled to or adjacent to edges of said turbine engagement walls and to or adjacent to edges of said exhaust diffuser engagement wall; and

a plurality of substantially planar plates (22) coupled to or adjacent to other edges (420) of said turbine engagement wall and to or adjacent to other edges (320) of said exhaust diffuser engagement wall, such that said substantially planar

plates approximate a portion of a cycle of an involute curve (700);

said apparatus configured to enclose the radial exhaust diffuser; and the top plate, bottom plate, substantially straight sidewalls, and substantially straight plates are engaged so that exhaust from the radial exhaust diffuser exits the apparatus via an outlet side.

2. The apparatus of claim 1, the wherein the top plate, bottom plate, substantially straight sidewalls (120), and substantially straight plates are engaged by welds.

3. The apparatus of claim 1, wherein the top plate, bottom plate, substantially straight sidewalls (120), and substantially straight plates are engaged by bolts.

4. The apparatus of any of the preceding claims, having at least 4 but not more than 12 substantially straight plates (22).

5. The apparatus of any of the preceding claims, having at least 6 but not more than 10 substantially straight plates (22).

6. The apparatus of any of the preceding claims, having 8 substantially straight plates (22).

7. A radial exhaust gas turbine apparatus comprising:

an inlet section (102);

a compressor section (104) operatively coupled to the inlet section;

a combustor section (106) operatively coupled to the compressor section;

a turbine section (108) operatively coupled to the combustor section;

a radial exhaust diffuser (112) operatively coupled to the turbine section (108); and

an involute type casing enclosing a radial exhaust diffuser, wherein the involute type casing is in accordance with any of claims 1 to 6.

8. The apparatus of claim 7, the wherein the top plate, bottom plate, substantially straight walls (10), and substantially straight plates (22) are engaged by welds.

9. The apparatus of claim 7, wherein the top plate, bottom plate, substantially straight walls (120), and substantially straight plates (22) are engaged by bolts.

10. The apparatus of any of claims 7 to 9, having at least 4 but not more than 12 substantially straight plates (22).

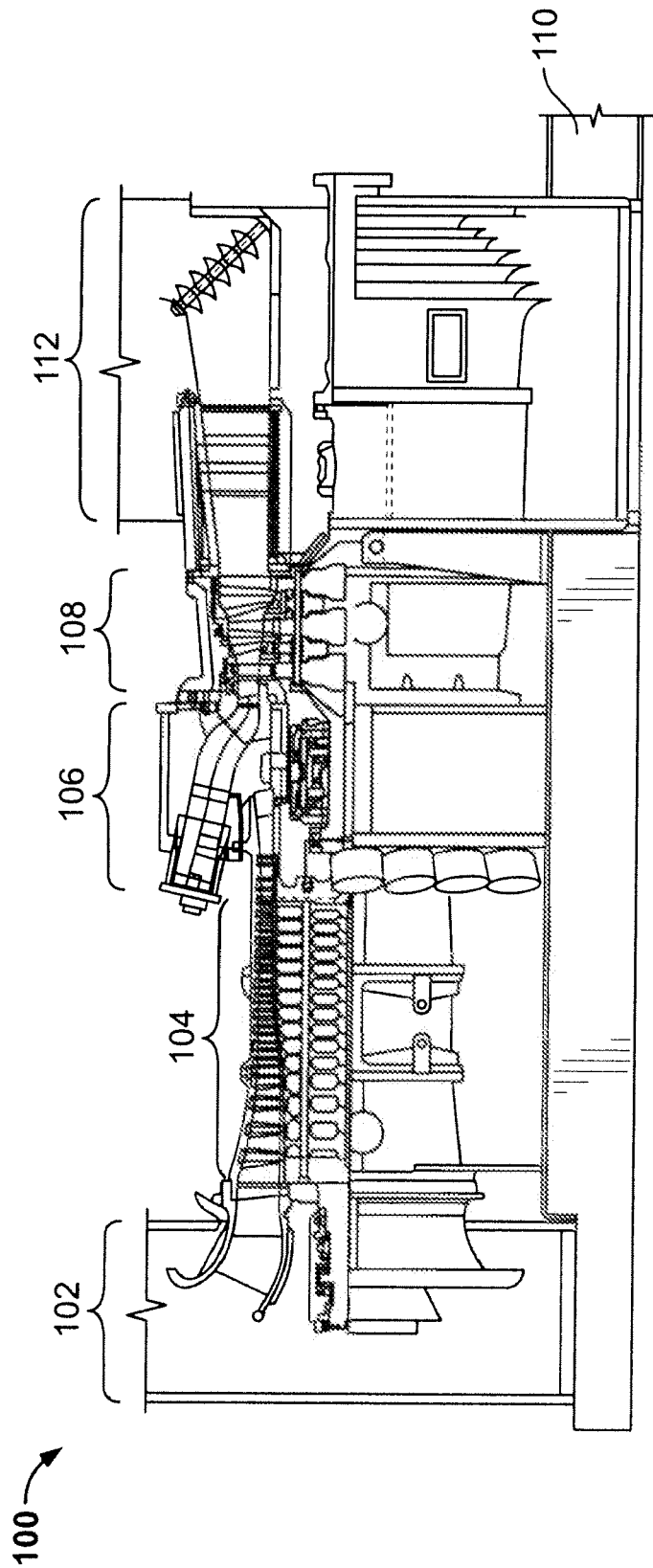
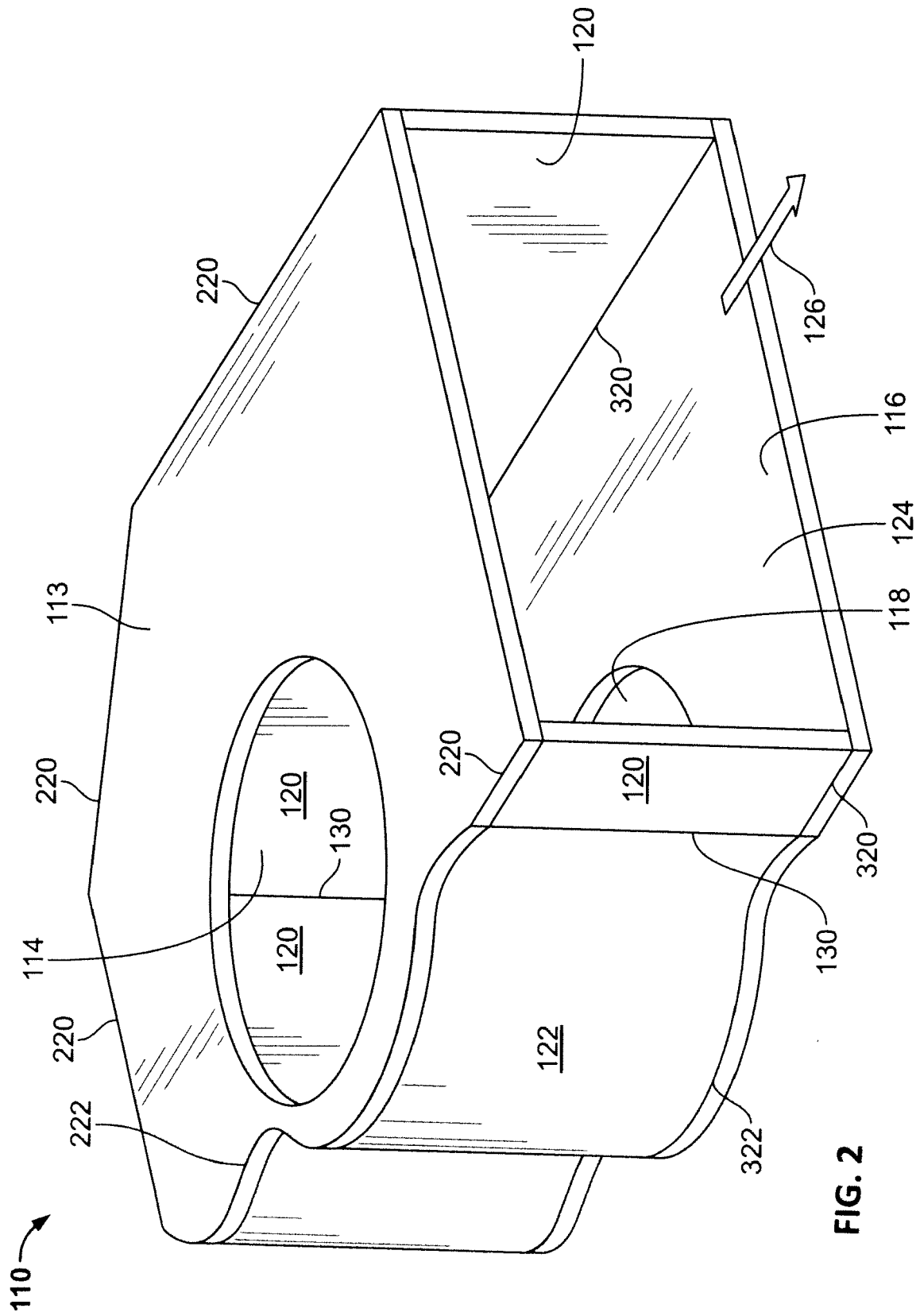
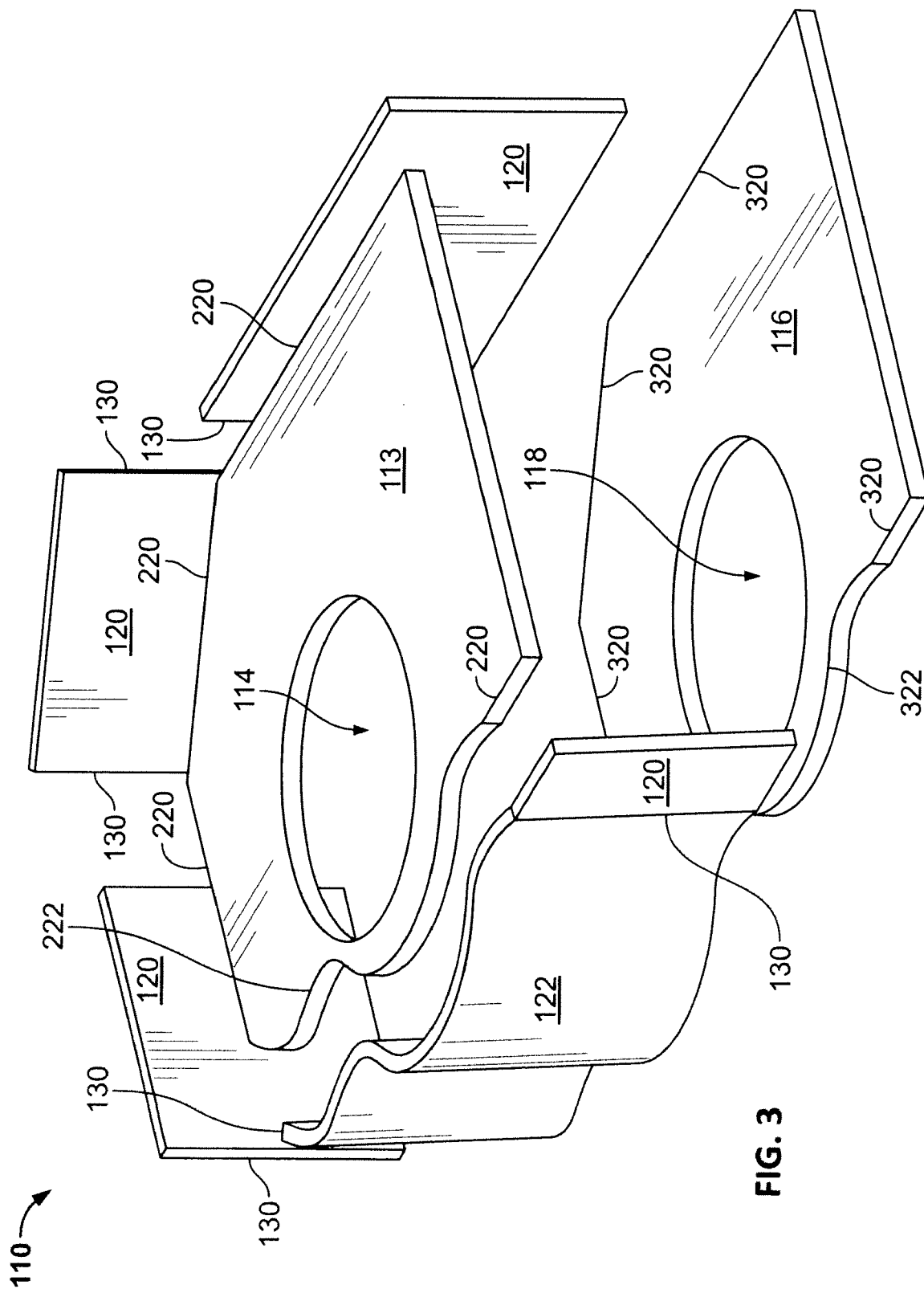


FIG. 1





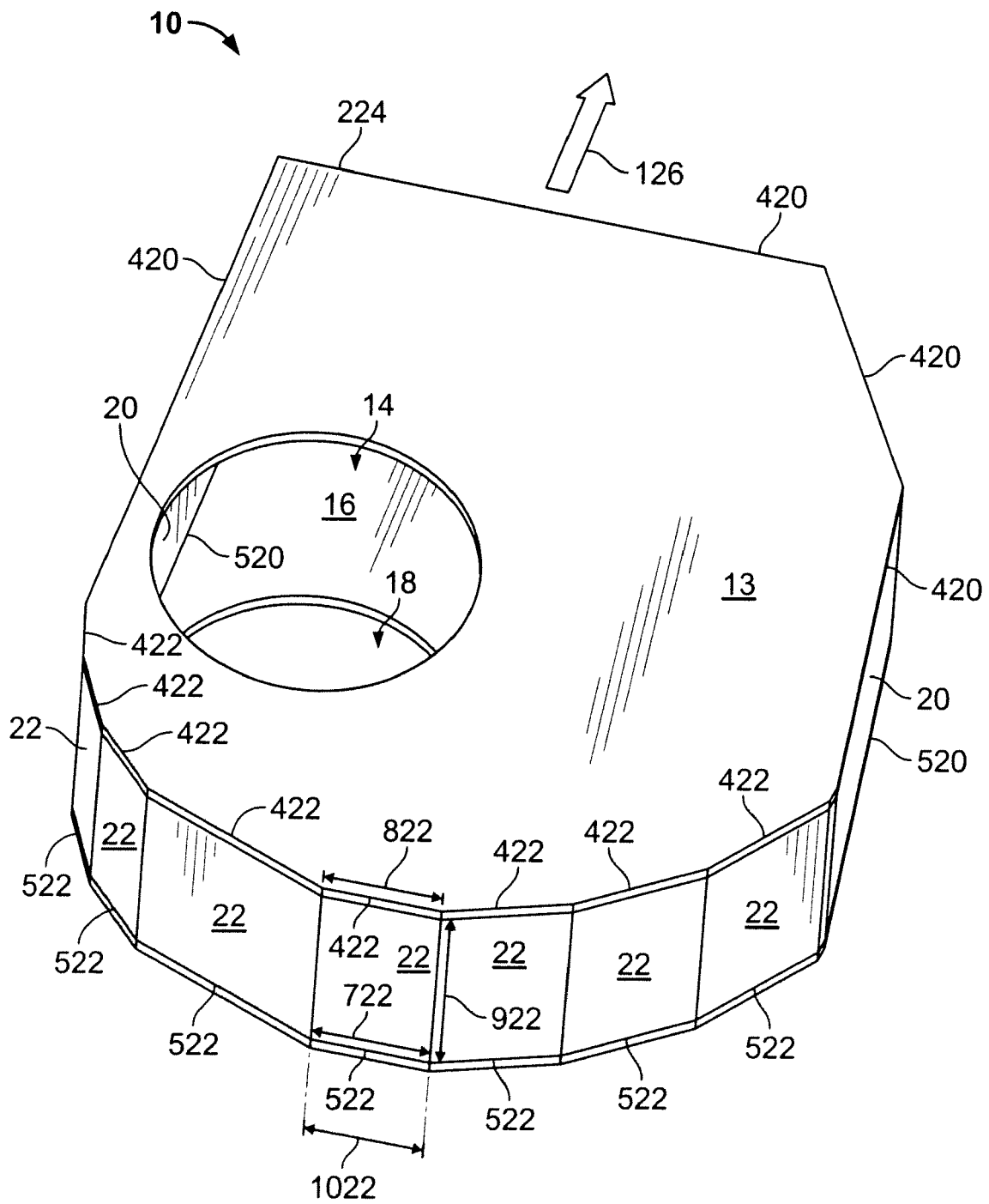


FIG. 4

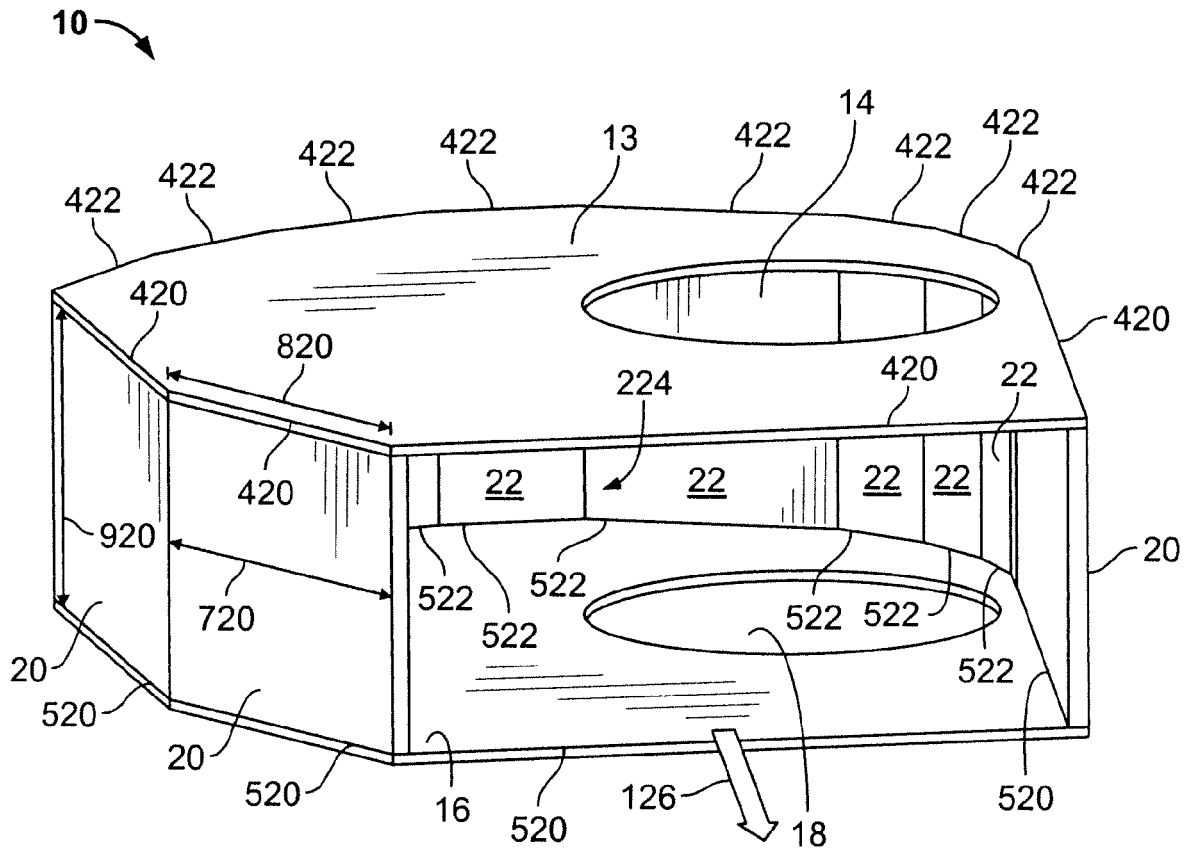


FIG. 5

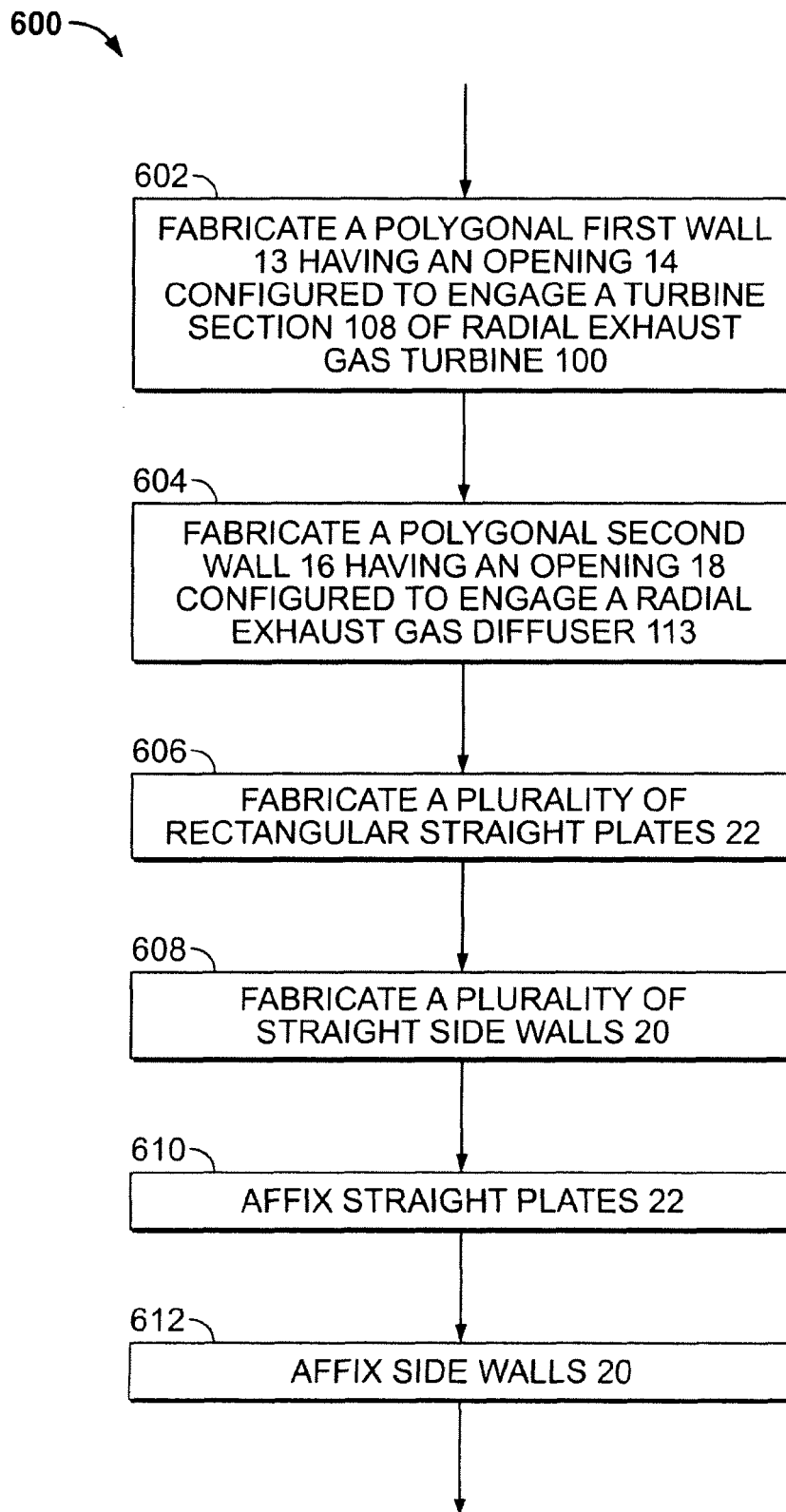


FIG. 6

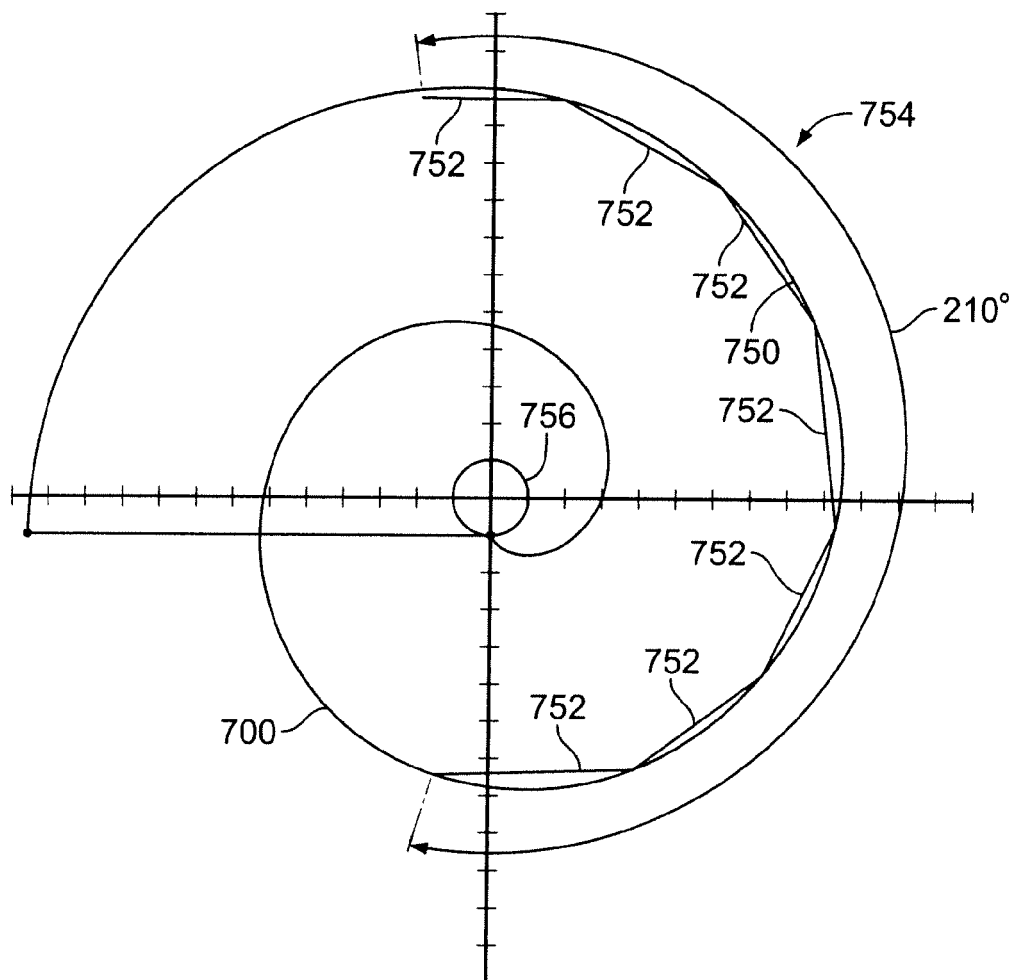


FIG. 7