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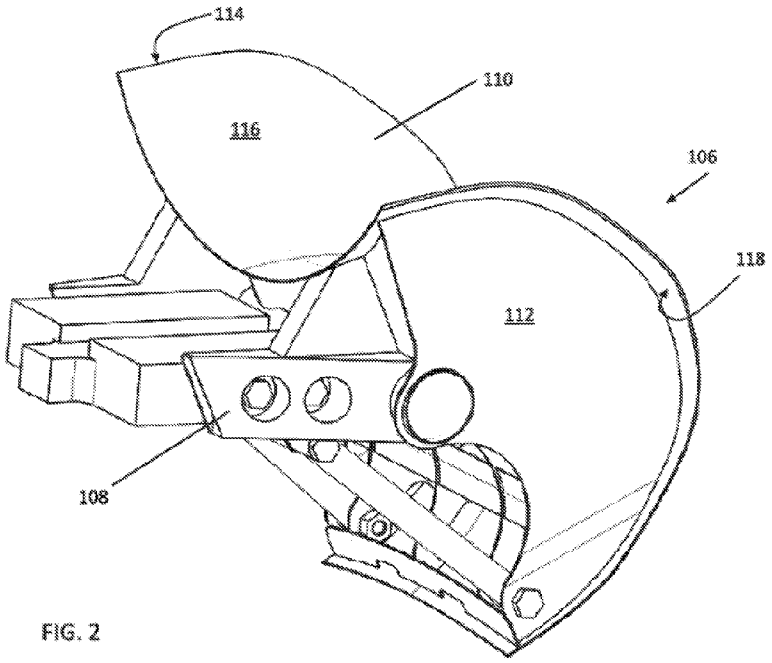

FIG. 2

(57) Abstract: A guide vane for use in a compressor discharge plenum of a gas turbine engine is disclosed. The guide vane comprises a guide support system, a first side panel, a second side panel, and a deflector panel secured to the mounting system and extending between the first side panel and the second side panel. The deflector panel has a curved profile substantially in accordance with Cartesian coordinate values of X, Y, and Z as set forth in Table 1 where the X, Y, and Z values are in inches from a center point of a bottom surface of the deflector panel. The coordinate values are connected by smooth continuing arcs to form profile sections and the profile sections are joined together smoothly to form the curved profile of the guide vane.

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[Continued on next page]

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DIFFUSER GUIDE VANE

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims priority to U.S. Nonprovisional Patent Application Serial No. 16/179,378 filed Nov. 2, 2018. This application also claims priority to U.S. Nonprovisional Patent Application Serial No. 16/178,677 filed Nov. 2, 2018. The disclosure of each is incorporated by reference herein in its entirety.

TECHNICAL FIELD

[0002] This disclosure relates generally to a guide vane for use in a compressor discharge region of a gas turbine engine and more specifically to surface profile for the diffuser guide vane.

BACKGROUND OF THE DISCLOSURE

[0003] A gas turbine engine typically comprises a multi-stage compressor coupled to a multi-stage turbine via an axial shaft. Air enters the gas turbine engine through the compressor where its temperature and pressure increase as it passes through subsequent stages of the compressor. The compressed air is then directed to one or more combustors where it mixes with a fuel source to create a combustible mixture. This mixture is ignited in the combustors to create a flow of hot combustion gases. These gases are directed into the turbine causing the turbine to rotate, thereby driving the compressor. The output of the gas turbine engine can be mechanical thrust through exhaust from the turbine or shaft power from the rotation of an axial shaft, where the axial shaft can drive a generator to produce electricity.

[0004] The compressor and turbine each comprise a plurality of rotating blades and stationary vanes having an airfoil extending into the flow of compressed air or flow of hot combustion gases. Each blade or vane has a particular set of design criteria which must be

met in order to provide the necessary work to the passing flow through the compressor and the turbine.

[0005] The air from the compressor is directed to a compressor discharge plenum, which is a large volume area contained within the engine case and receives compressed air from the compressor and is in fluid communication with the combustion sections of the gas turbine engine. For industrial gas turbines having one or more transition ducts connecting the combustor to the turbine, the one or more transition ducts are positioned within the compressor discharge plenum. Compressed air in the compressor discharge plenum typically circulates throughout the plenum and can cool the one or more transition ducts before the air moves towards the combustion section. However, due to the large volume of air passing into the compressor discharge plenum, the airflow through the plenum can be non-uniform and recirculate in certain regions of the compressor discharge plenum, thus creating instabilities between the individual combustion systems due to the fluctuations in airflow.

BRIEF SUMMARY OF THE DISCLOSURE

[0006] The following presents a simplified summary of the disclosure to provide a basic understanding of some aspects thereof. This summary is not an extensive overview of the application. It is not intended to identify critical elements of the disclosure or to delineate the scope of the disclosure. Its sole purpose is to present some concepts of the disclosure in a simplified form as a prelude to the more detailed description that is presented elsewhere herein.

[0007] The present disclosure discloses a diffuser guide vane having a profile configured to direct a flow of compressed air from a compressor and towards a combustion system.

[0008] In an embodiment of the disclosure, a guide vane for a compressor discharge plenum is provided. The guide vane comprises a guide support system, a first side panel, a

second side panel, and a deflector panel secured to the mounting system and extending between the first side panel and the second side panel. The deflector panel has a curved profile substantially in accordance with Cartesian coordinate values X, Y, and Z as set forth in Table 1. The X, Y, and Z values are measured in inches from a center point of a bottom surface of the deflector panel, such that when the coordinate values are connected by smooth continuing arcs, a plurality of profile sections are defined. The curved profile is formed when the profile sections are joined together with smooth curves.

[0009] In an alternate embodiment of the disclosure, a guide vane for a compressor discharge plenum is provided. The guide vane comprises a guide support system, a first side panel, a second side panel, and a deflector panel secured to the mounting system and extending between the first side panel and the second side panel. The deflector panel has a curved profile within an envelope of approximately -0.050 to +0.050 inches in a direction normal to any surface of the curved profile. The curved profile is substantially in accordance with Cartesian coordinate values X, Y, and Z as set forth in Table 1 wherein the X, Y, and Z values are in inches and measured from a center point of a bottom surface of the deflector panel. When the coordinate values are connected by smooth continuing arcs, profile sections of the deflector panel are defined. The curved profile is formed by joining together the profile sections with smooth curves.

[0010] In yet another an embodiment of the disclosure, a compressor discharge region of a gas turbine engine is provided. The compressor discharge region comprises a compressor discharge case, a bullhorn bracket coupled to a portion of the compressor discharge case, and a guide vane for directing air flow in the compressor discharge plenum. The guide vane, which is coupled to the bullhorn bracket, comprises a guide support system, a first side panel, a second side panel, and a deflector panel secured to the mounting system and extending between the first side panel and the second side panel. The deflector panel has a curved profile substantially in accordance with Cartesian coordinate values X, Y, and Z as

set forth in Table 1, where the X, Y, and Z values are in inches measured from a center point of a bottom surface of the deflector panel. When the coordinate values are connected by smooth continuing arcs, profile sections of the deflector panel are defined. The guide vane is formed by joining the profile sections together using smooth curves.

[0011] These and other features of the present disclosure can be best understood from the following description and claims.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

[0012] The present disclosure is described in detail below with reference to the attached drawing figures, wherein:

[0013] FIG. 1 is a side elevation view of a portion of a gas turbine engine in accordance with an embodiment of the disclosure.

[0014] FIG. 2 is a perspective view of a guide vane in accordance with an embodiment of the disclosure.

[0015] FIG. 3 is an alternate perspective view of a guide vane in accordance with an embodiment of the disclosure.

[0016] FIG. 4 is a perspective view of a deflector panel of the guide vane of FIGS. 2 and 3 in accordance with an embodiment of the disclosure.

[0017] FIG. 5 is an alternate perspective view of the deflector panel of FIG. 4 in accordance with an embodiment of the disclosure.

[0018] FIG. 6 depicts a pair of profile sections of the deflector panel in accordance with an embodiment of the disclosure.

[0019] FIG. 7 depicts the coordinate values, profile sections and curved profile of the deflector panel in accordance with an embodiment of the disclosure.

[0020] FIG. 8 depicts the profile sections of the deflector panel in accordance with an embodiment of the disclosure.

[0021] FIG. 9 depicts the profile sections and curved profile of the deflector panel in accordance with an embodiment of the disclosure.

[0022] FIG. 10 is a perspective view of a transition duct in accordance with the prior art.

[0023] FIG. 11 is an alternate perspective view of a portion of the transition duct on FIG. 10 in accordance with the prior art.

[0024] FIG. 12 is a cross section view of a portion of a gas turbine engine in accordance with an embodiment of the present disclosure.

[0025] FIG. 13 is an elevation view of a damping member in accordance with an embodiment of the present disclosure.

[0026] FIG. 14 is a cross section view taken through the damping member of FIG. 13 in accordance with an embodiment of the present disclosure.

[0027] FIG. 15 is a partial cross section of the gas turbine engine depicted in FIG. 12.

[0028] FIG. 16 is a perspective view of a portion of a transition duct in accordance with an embodiment of the present disclosure.

[0029] FIG. 17 is an elevation view of the transition duct in accordance with an embodiment of the present disclosure.

[0030] FIG. 18 is a cross section view taken through a portion of the transition duct of FIG. 17.

[0031] FIG. 19 is an exploded perspective view of a portion of a transition duct in accordance with an alternate embodiment of the present disclosure.

[0032] FIG. 20 is a flowchart illustrating a method of adjusting a location of an inlet to a transition duct in a gas turbine engine.

DETAILED DESCRIPTION

[0033] The present disclosure is intended for use in a gas turbine engine, such as a gas turbine used for power generation. As such, the present disclosure is capable of being used in a variety of turbine operating environments, regardless of the manufacturer.

[0034] As those skilled in the art will readily appreciate, a gas turbine engine is circumferentially disposed about an engine centerline, or axial centerline axis. The engine includes a compressor, a combustion section and a turbine with the turbine coupled to the compressor via an engine shaft. As is well known in the art, air compressed in the compressor mixes with fuel and is burned in the combustion section and expanded in the turbine. The air compressed in the compressor and the fuel mixture expanded in the turbine can both be referred to as a "hot gas stream flow" or combustion gases. The turbine includes rotors that, in response to the fluid expansion, rotate, thereby driving the compressor. The turbine comprises alternating rows of rotary turbine blades, and static airfoils, often referred to as vanes.

[0035] The present disclosure is depicted in FIGS. 1-9. A portion of the gas turbine engine in which the present disclosure can operate is depicted in FIG. 1. A compressor discharge region 100 comprises a compressor discharge case 102 which envelopes or surrounds an exit area of the compressor and receives air from the compressor. A bullhorn bracket 104 is coupled to a portion of the compressor discharge case 102 and a guide vane 106 is provided for directing airflow from the compressor and through the compressor discharge plenum. The air flow is indicated by a series of arrows in FIG. 1.

[0036] Referring now to FIGS. 1-3, the guide vane 106 comprises a guide support system 108 having multiple individual components used in supporting a deflector panel 110 and for mounting the deflector panel in the proper location of the compressor discharge plenum 102. The exact configuration of the guide support system 108 can vary depending on the specific engine configuration. One such acceptable mounting configuration is to couple

the guide vane 106 to the bullhorn bracket 104. The bullhorn bracket 104 is also typically used to support a transition duct 105.

[0037] The guide vane 106 further comprises a first side panel 112 and a second side panel 114, where the second side panel 114 is positioned generally parallel to the first side panel 112. The deflector panel 110 is secured to the guide support system 108 and extends between the first side panel 112 and the second side panel 114. The deflector panel 110 can be secured by a variety of means such as welding or a plurality of fasteners (not depicted).

[0038] The deflector panel 110 has a curved profile substantially in accordance with Cartesian coordinate values of X, Y, and Z as set forth in Table 1. The X, Y, and Z values of Table 1 correspond to a series of points along opposing surfaces 116 and 118. The opposing surfaces 116 and 118 are typically at least 0.062 inches thick but may vary. The X, Y, and Z Cartesian coordinate values are measured in inches from a center point of a bottom surface of the deflector panel, as shown in FIG. 7. The representative Cartesian coordinates are shown in FIGS. 6 and 7 and are connected by smooth continuing arcs to thereby define profile sections 120 of the deflector panel 110. The profile sections 120, which are shown in FIG. 8, are joined together smoothly to form a curved profile 122 of the deflector panel 110. The curved profile is shown in FIG. 9.

[0039] For the embodiment of the disclosure discussed herein and depicted in FIGS. 2-9, the deflector panel 110 has a height of approximately 18 inches, as measured from a midpoint of the lower most section of the deflector panel to an upper most section at the opposing end of the deflector panel. For purposes of defining the deflector panel 110, this origin corresponds to a Z value of 0.000.

[0040] The guide vane 106 further comprises a mounting system 124 for securing the guide vane to the compressor discharge case 102. The guide vane 106 can be secured to the compressor discharge case 102, via the bullhorn bracket 104, with a plurality of fasteners, as depicted in FIG. 1. The guide vane 106, which serves to direct compressed air from all areas

of the compressor, may be fabricated in multiple parts in order to create the overall guide vane shape in the compressor discharge region 100.

[0041] The deflector panel 110 operates in a relatively low temperature environment, as compressed air exiting the engine compressor enters the compressor discharge case at approximately 700 deg. F. As such, the deflector panel 110 and other related components can be fabricated from a low temperature material such as stainless steel. The deflector panel 110 can be fabricated as a forging or casting.

[0042] The values of Table 1 for determining the profile of the deflector panel 110 are generated and shown to three decimal places. These values in Table 1 are for a nominal, uncoated deflector panel. However, there are typical manufacturing tolerances as well as possible coatings, which can cause the profile of the deflector panel to vary from the values of Table 1. Accordingly, in an alternate embodiment of the disclosure, the deflector panel 110 can have a curved profile 122 within an envelope of approximately -0.050 to +0.050 inches in a direction normal to any surface location of the curved profile. This range for the curved profile accounts for manufacturing variations or assembly issues of the guide vane 106.

[0043] A number of improvements in cooling and engine operation occur as a result of this disclosure. First, the deflector panel 110 of the guide vane 106 forms an important part of a flow path in the compressor discharge region 100 between a compressor and a combustor of a gas turbine engine, such that airflow from the compressor enters the compressor discharge region 100 and is directed radially outward towards the transition duct 105, thus improving cooling of the transition ducts. Furthermore, the deflector panel 110 also helps direct airflow forward towards an inlet of the combustor 130.

[0044] In addition, the curved profile 122 for deflector panel 110 is configured such that it helps to maintain attachment of the airflow from the compressor, reducing the likelihood of flow separation and pressure loss.

[0045] The coordinate values given in Table 1 below provide a nominal profile envelope for the deflector panel disclosed herein.

TABLE 1

X	Y	Z
1.070	9.149	18.908
0.462	8.446	17.661
-0.091	7.533	16.529
-0.573	6.435	15.539
-0.975	5.178	14.716
-1.285	3.793	14.080
-1.496	2.314	13.647
-1.603	0.778	13.427
-1.603	-0.778	13.427
-1.496	-2.314	13.647
-1.285	-3.793	14.080
-0.975	-5.178	14.716
-0.573	-6.435	15.539
-0.091	-7.533	16.529
0.462	-8.446	17.661
1.070	-9.149	18.908
1.000	9.218	18.765
0.394	8.497	17.523
-0.156	7.571	16.396
-0.636	6.461	15.411
-1.035	5.195	14.593
-1.343	3.804	13.961
-1.552	2.320	13.531
-1.659	0.780	13.314
-1.659	-0.780	13.314
-1.552	-2.320	13.531
-1.343	-3.804	13.961
-1.035	-5.195	14.593
-0.636	-6.461	15.411
-0.156	-7.571	16.396
0.394	-8.497	17.523
1.000	-9.218	18.765
1.948	9.181	18.506
1.448	8.465	17.227
0.996	7.541	16.070
0.602	6.433	15.062
0.277	5.169	14.229
0.026	3.781	13.589
-0.143	2.305	13.154

-0.229	0.774	12.935
-0.229	-0.774	12.935
-0.143	-2.305	13.154
0.026	-3.781	13.589
0.277	-5.169	14.229
0.602	-6.433	15.062
0.996	-7.541	16.070
1.448	-8.465	17.227
1.948	-9.181	18.506
3.825	9.223	17.511
3.244	8.474	16.302
2.720	7.528	15.211
2.264	6.408	14.264
1.888	5.140	13.481
1.600	3.756	12.880
1.404	2.288	12.474
1.305	0.768	12.268
1.305	-0.768	12.268
1.404	-2.288	12.474
1.600	-3.756	12.880
1.888	-5.140	13.481
2.264	-6.408	14.264
2.720	-7.528	15.211
3.244	-8.474	16.302
3.825	-9.223	17.511
5.701	9.219	16.241
5.023	8.438	15.135
4.413	7.473	14.140
3.885	6.345	13.279
3.450	5.081	12.569
3.116	3.707	12.025
2.891	2.256	11.657
2.777	0.757	11.472
2.777	-0.757	11.472
2.891	-2.256	11.657
3.116	-3.707	12.025
3.450	-5.081	12.569
3.885	-6.345	13.279
4.413	-7.473	14.140
5.023	-8.438	15.135
5.701	-9.219	16.241
7.582	9.123	14.406
6.776	8.305	13.491
6.054	7.322	12.671
5.431	6.195	11.964
4.919	4.947	11.383
4.528	3.603	10.938

4.263	2.190	10.638
4.130	0.734	10.486
4.130	-0.734	10.486
4.263	-2.190	10.638
4.528	-3.603	10.938
4.919	-4.947	11.383
5.431	-6.195	11.964
6.054	-7.322	12.671
6.776	-8.305	13.491
7.582	-9.123	14.406
9.074	8.808	11.921
8.171	7.969	11.289
7.367	6.991	10.726
6.677	5.890	10.242
6.113	4.689	9.847
5.682	3.407	9.546
5.392	2.067	9.342
5.246	0.693	9.240
5.246	-0.693	9.240
5.392	-2.067	9.342
5.682	-3.407	9.546
6.113	-4.689	9.847
6.677	-5.890	10.242
7.367	-6.991	10.726
8.171	-7.969	11.289
9.074	-8.808	11.921
9.789	8.164	9.076
8.883	7.352	8.759
8.083	6.423	8.479
7.402	5.392	8.241
6.851	4.278	8.048
6.434	3.100	7.903
6.155	1.878	7.805
6.015	0.629	7.756
6.015	-0.629	7.756
6.155	-1.878	7.805
6.434	-3.100	7.903
6.851	-4.278	8.048
7.402	-5.392	8.241
8.083	-6.423	8.479
8.883	-7.352	8.759
9.789	-8.164	9.076
9.706	7.355	5.975
8.866	6.612	6.007
8.128	5.768	6.035
7.506	4.834	6.060
7.008	3.829	6.079

6.635	2.771	6.093
6.389	1.676	6.103
6.266	0.561	6.107
6.266	-0.561	6.107
6.389	-1.676	6.103
6.635	-2.771	6.093
7.008	-3.829	6.079
7.506	-4.834	6.060
8.128	-5.768	6.035
8.866	-6.613	6.007
9.706	-7.355	5.975
8.647	6.746	3.426
7.970	6.039	3.686
7.381	5.249	3.913
6.887	4.386	4.102
6.493	3.466	4.254
6.201	2.504	4.366
6.009	1.513	4.440
5.913	0.506	4.477
5.913	-0.506	4.477
6.009	-1.513	4.440
6.201	-2.504	4.366
6.493	-3.466	4.254
6.887	-4.386	4.102
7.381	-5.249	3.913
7.970	-6.039	3.686
8.647	-6.746	3.426
6.983	6.433	1.655
6.521	5.697	1.990
6.120	4.909	2.281
5.784	4.076	2.525
5.514	3.206	2.720
5.312	2.309	2.867
5.178	1.393	2.964
5.111	0.466	3.013
5.111	-0.466	3.013
5.178	-1.393	2.964
5.312	-2.309	2.867
5.514	-3.206	2.720
5.784	-4.076	2.525
6.120	-4.909	2.281
6.521	-5.697	1.990
6.983	-6.433	1.655
5.001	6.411	0.531
4.750	5.613	0.839
4.531	4.792	1.107
4.345	3.950	1.334

4.194	3.091	1.518
4.080	2.218	1.659
4.003	1.335	1.753
3.964	0.446	1.800
3.964	-0.446	1.800
4.002	-1.335	1.753
4.080	-2.218	1.659
4.194	-3.091	1.518
4.345	-3.950	1.334
4.531	-4.792	1.107
4.750	-5.613	0.839
5.001	-6.411	0.531
3.050	6.566	-0.086
2.931	5.716	0.154
2.826	4.855	0.362
2.738	3.985	0.539
2.666	3.108	0.682
2.612	2.225	0.792
2.575	1.337	0.866
2.556	0.446	0.903
2.556	-0.446	0.903
2.575	-1.337	0.866
2.612	-2.225	0.792
2.666	-3.108	0.682
2.738	-3.985	0.539
2.826	-4.855	0.362
2.931	-5.716	0.154
3.050	-6.566	-0.086
1.231	6.778	-0.416
1.175	5.886	-0.242
1.127	4.988	-0.093
1.086	4.087	0.031
1.054	3.182	0.131
1.030	2.275	0.206
1.014	1.366	0.256
1.006	0.455	0.282
1.006	-0.455	0.282
1.014	-1.366	0.256
1.030	-2.275	0.206
1.054	-3.182	0.131
1.086	-4.087	0.031
1.127	-4.988	-0.093
1.175	-5.886	-0.242
1.231	-6.778	-0.416
1.889	9.247	18.355
1.391	8.514	17.081
0.941	7.576	15.930

0.550	6.456	14.929
0.227	5.184	14.102
-0.021	3.791	13.467
-0.190	2.310	13.036
-0.275	0.776	12.818
-0.275	-0.776	12.818
-0.190	-2.310	13.036
-0.021	-3.791	13.467
0.227	-5.184	14.102
0.550	-6.456	14.929
0.941	-7.576	15.930
1.391	-8.514	17.081
1.889	-9.247	18.355
3.752	9.282	17.360
3.174	8.517	16.158
2.654	7.558	15.074
2.202	6.427	14.133
1.829	5.152	13.357
1.543	3.763	12.762
1.349	2.291	12.359
1.251	0.769	12.155
1.251	-0.769	12.155
1.349	-2.291	12.359
1.543	-3.763	12.762
1.829	-5.152	13.357
2.202	-6.427	14.133
2.654	-7.558	15.074
3.174	-8.517	16.158
3.752	-9.282	17.360
5.612	9.272	16.096
4.938	8.476	14.997
4.333	7.498	14.009
3.809	6.361	13.155
3.378	5.090	12.452
3.047	3.712	11.913
2.824	2.258	11.549
2.712	0.758	11.365
2.712	-0.758	11.365
2.824	-2.258	11.549
3.047	-3.712	11.913
3.378	-5.090	12.452
3.809	-6.361	13.155
4.333	-7.498	14.009
4.938	-8.476	14.997
5.612	-9.272	16.096
7.470	9.169	14.279
6.669	8.337	13.370

5.953	7.343	12.557
5.336	6.209	11.856
4.829	4.955	11.280
4.441	3.607	10.840
4.179	2.191	10.542
4.047	0.735	10.392
4.047	-0.735	10.392
4.179	-2.191	10.542
4.441	-3.607	10.840
4.829	-4.955	11.280
5.336	-6.209	11.856
5.953	-7.343	12.557
6.669	-8.337	13.370
7.470	-9.169	14.279
8.940	8.849	11.827
8.043	7.997	11.199
7.245	7.010	10.640
6.561	5.903	10.161
6.002	4.696	9.769
5.575	3.411	9.471
5.288	2.069	9.269
5.143	0.693	9.168
5.143	-0.693	9.168
5.288	-2.069	9.269
5.575	-3.411	9.471
6.002	-4.696	9.769
6.561	-5.903	10.161
7.245	-7.010	10.640
8.043	-7.997	11.199
8.940	-8.849	11.827
9.647	8.208	9.026
8.746	7.386	8.711
7.951	6.448	8.433
7.275	5.410	8.196
6.727	4.291	8.005
6.313	3.109	7.860
6.036	1.883	7.763
5.897	0.630	7.715
5.897	-0.630	7.715
6.036	-1.883	7.763
6.313	-3.109	7.860
6.727	-4.291	8.005
7.275	-5.410	8.196
7.951	-6.448	8.433
8.746	-7.386	8.711
9.647	-8.208	9.026
9.575	7.412	5.980

8.736	6.659	6.012
7.999	5.805	6.040
7.379	4.863	6.064
6.881	3.851	6.084
6.510	2.786	6.098
6.263	1.685	6.108
6.141	0.564	6.112
6.141	-0.564	6.112
6.263	-1.685	6.108
6.510	-2.786	6.098
6.881	-3.851	6.084
7.379	-4.863	6.064
7.999	-5.805	6.040
8.736	-6.659	6.012
9.575	-7.412	5.980
8.535	6.807	3.469
7.857	6.091	3.729
7.266	5.292	3.956
6.772	4.421	4.147
6.378	3.493	4.298
6.085	2.523	4.411
5.892	1.524	4.485
5.796	0.510	4.522
5.796	-0.510	4.522
5.892	-1.524	4.485
6.085	-2.523	4.411
6.378	-3.493	4.298
6.772	-4.421	4.147
7.266	-5.292	3.957
7.857	-6.091	3.729
8.535	-6.807	3.469
6.886	6.489	1.725
6.424	5.745	2.061
6.022	4.949	2.352
5.684	4.108	2.597
5.414	3.231	2.793
5.211	2.327	2.940
5.077	1.404	3.037
5.010	0.469	3.086
5.010	-0.469	3.086
5.077	-1.404	3.037
5.211	-2.327	2.940
5.414	-3.231	2.793
5.684	-4.108	2.597
6.022	-4.949	2.352
6.424	-5.745	2.061
6.886	-6.489	1.725

4.920	6.448	0.630
4.670	5.644	0.937
4.451	4.817	1.204
4.266	3.971	1.431
4.115	3.107	1.615
4.001	2.229	1.755
3.923	1.342	1.850
3.885	0.448	1.897
3.885	-0.448	1.897
3.923	-1.342	1.850
4.001	-2.229	1.755
4.115	-3.107	1.615
4.266	-3.971	1.431
4.451	-4.817	1.204
4.670	-5.644	0.937
4.920	-6.448	0.630
2.990	6.571	0.035
2.872	5.719	0.272
2.769	4.857	0.478
2.681	3.987	0.653
2.610	3.109	0.796
2.555	2.225	0.905
2.519	1.337	0.978
2.500	0.446	1.015
2.500	-0.446	1.015
2.519	-1.337	0.978
2.555	-2.225	0.905
2.610	-3.109	0.796
2.681	-3.987	0.653
2.768	-4.857	0.478
2.872	-5.719	0.272
2.990	-6.571	0.035
1.188	6.738	-0.284
1.133	5.851	-0.113
1.086	4.959	0.033
1.047	4.063	0.155
1.015	3.163	0.253
0.991	2.261	0.326
0.975	1.358	0.376
0.967	0.453	0.401
0.967	-0.453	0.401
0.975	-1.358	0.376
0.991	-2.261	0.326
1.015	-3.163	0.253
1.047	-4.063	0.155
1.086	-4.959	0.033
1.133	-5.851	-0.113

1.188	-6.738	-0.284
0.000	-6.925	-0.548
0.000	-6.008	-0.411
0.000	-5.088	-0.293
0.000	-4.166	-0.196
0.000	-3.242	-0.118
0.000	-2.317	-0.060
0.000	-1.391	-0.022
0.000	-0.464	-0.002
0.000	0.464	-0.002
0.000	1.391	-0.022
0.000	2.317	-0.060
0.000	3.242	-0.118
0.000	4.166	-0.196
0.000	5.088	-0.293
0.000	6.008	-0.411
0.000	6.925	-0.548
0.000	6.846	-0.408
0.000	5.940	-0.274
0.000	5.030	-0.160
0.000	4.119	-0.064
0.000	3.205	0.012
0.000	2.290	0.069
0.000	1.375	0.107
0.000	0.458	0.126
0.000	-0.458	0.126
0.000	-1.375	0.107
0.000	-2.290	0.069
0.000	-3.205	0.012
0.000	-4.119	-0.064
0.000	-5.030	-0.160
0.000	-5.940	-0.274
0.000	-6.846	-0.408

[0046] Some embodiments of the disclosure relate generally to a method and apparatus for mounting a transition duct in a gas turbine engine. More specifically, some embodiments of the present disclosure relate to the use of a damping member and adjustable mounting system for use in securing a transition duct within a gas turbine engine.

[0047] Due to the geometry of a gas turbine engine, often times the combustion system is not directly in radial or axial alignment with the compressor or the turbine inlet.

For example, where a plurality of can annular combustors are utilized, the individual combustors are typically oriented at an angle relative to the engine centerline. As such, it is necessary to connect the angled combustors to the inlet of the turbine. A transition duct 10 in accordance with the prior art is depicted in FIGS. 10 and 11. The transition duct 10 has a generally circular inlet end 12 which tapers to an arc-shaped frame-like outlet end 14 that is coupled to an inlet of the turbine for directing combustion gases from the combustion system and to the turbine. As a result of the complex and changing shape and function of the transition duct, the transition duct is subject to extreme vibrations, which can cause wear and distress on the transition duct and its adjacent engine components.

[0048] Furthermore, due to the complex and changing geometry between a combustion system and a turbine, it is often difficult to properly align a transition duct connecting the combustion system to the turbine. Traditional transition ducts utilize a fixed mounting system 16 and do not compensate for misalignment between a combustion system and the turbine.

[0049] Some embodiments of the present disclosure are depicted in FIGS. 12-19. Referring initially to FIGS. 12-15, a system 300 for reducing vibrations between a combustion system and a gas turbine engine is provided. The system 300 comprises a transition duct 302 connecting a combustion system 304 to an inlet 306 of a turbine. A first mounting mechanism 308 connects the transition duct 302 to the turbine inlet 306 while a second mounting system 310 couples a forward portion of the transition duct 302 to an aft end of the combustion system 304. The first mounting mechanism 308 can be a hinge bracket or other mechanism attached to the turbine inlet 306, while the second mounting mechanism 310 is preferably a fixed bracket secured to a frame in the compressor discharge case 312.

[0050] Referring to FIGS. 13-15, the system 300 also comprises a damping member 314 positioned between the first mounting mechanism 308 and the turbine inlet of the gas

turbine engine 300. This is shown as region A in FIG. 12 and also in FIG. 15. The same damping member can be utilized in other mounting regions, such as region B, which is between the second mounting mechanism 310 and the gas turbine engine 300. More specifically, the damping member 314 can be mounted between the bracket of the second mounting mechanism 310 and the compressor discharge case 312. A similar damping member can be placed in other component interfaces, such as between a diffuser guide vane 313 and its mounting structure in the compressor discharge case of the gas turbine engine.

[0051] Referring now to FIGS. 13 and 14, the damping member 314 comprises a flat plate-like configuration comprising one or more layers of composite material 316 positioned between multiple layers of sheet metal 318. This multi-layer arrangement is shown in cross section in FIG. 14. The damping member 314 also comprises a plurality of openings 320, where the openings 320 are in the layers of sheet metal 318 and are similar to punches in the sheet metal 318. Edges of raw sheet metal from the openings 320 engage the one or more layers of composite material 316 when the layers are sandwiched together. The one or more layers of composite material 316 can be a variety of materials. One such acceptable material is vermiculite due to its high temperature capability. When coupled with thin sheets of metal, this material works to absorb vibrations between adjacent combustor components.

[0052] Referring now to FIGS. 16-19, an alternate embodiment of the present disclosure is shown in which a transition duct includes an adjustable mounting system 700. Details of the adjustable mounting system are more clearly defined in FIGS. 18 and 19. The adjustable mounting system 700 comprises a support plate 702 secured to an inlet ring 704 of a transition duct. The support plate 702 can be secured to the inlet ring 704 by a variety of means such as welding or brazing. Alternatively, the support plate 702 can be integrally formed with the inlet ring 704, such as in a casting.

[0053] Referring now to FIG. 19, the support plate 702 further comprises a slot 706 and a plurality of clearance holes 708. In an embodiment of the present disclosure, the slot

706 is U-shaped, but the exact configuration and shape of the slot 706 can vary depending on preferred manufacturing techniques and other components of the adjustable mounting system 700. As shown in FIG. 19, the clearance holes 708 are circular. However, in an alternate embodiment of the present disclosure, the clearance holes 708 can be non-circular.

[0054] An H-block plate 710 is positioned adjacent a forward face 712 of the support plate 702. The H-block plate 710 also has a plurality of first holes 714 and a leg portion 716 extending through the slot 706 in the support plate 702. One or more backing plates 718 are positioned adjacent an aft face 720 of the support plate 702. The one or more backing plates 718 each have a second hole 722 located therein. For the embodiment of the present disclosure shown in FIGS. 16-19, two backing plates are utilized, each with a second hole 722, and each positioned on opposite sides of the leg portion 716 of the H-block plate 710. The exact configuration of the backing plates 718 can vary depending on the configuration of the support plate 702.

[0055] A plurality of fasteners 724 are utilized to couple the H-block plate 710, the support plate 702, and the one or more backing plates 718 together. In one embodiment of the present disclosure, the second holes 722 in the backing plates 718 are threaded such that the fasteners 724 engage the threads of the second holes 722, thus drawing the H-block 710 and backing plates 718 into contact with the support plate 702. In addition to the second holes 722 being threaded, alternate means by which the fasteners 724 can be secured in place include placing a nut or other retaining device on the threaded portion of the fastener 724 adjacent the one or more backing plates 718. Alternatively, the fasteners 724 can be tack welded to the H-block plate 710, or anti-rotation tabs (not shown) can be used to prevent the fasteners 724 from coming loose and backing out of the threaded second holes 722. Other similar retention methods can be used.

[0056] One of the advantages of the present disclosure, which is shown in more detail in FIGS. 16-18, is the ability to adjust the location of the inlet to a transition duct, or inlet ring

704, generally in a plane parallel to that of the support plate 702. As one skilled in the art will understand, the transition duct in which the adjustable mounting system 700 operates, is supported in place by a bracket 750. The bracket 750, commonly referred to as a bullhorn bracket, includes arms 752 and fingers 754 which engage openings created by the H-block plate 710 and the support plate 702 and support the weight of the transition duct, as shown in FIG. 16. This ability to adjust the location of the transition duct inlet is provided as a result of the plurality of clearance holes 708 compared to that of the plurality of first holes 714 and second holes 722. That is, the plurality of clearance holes 708 are larger in diameter than the plurality of first holes 714 and second holes 722, resulting in a gap 726. Due to the gap 726 between the fasteners 724 and the support plate 702, the inlet ring 704, and thus the transition duct, is capable of small planar adjustments until the fasteners 724 are locked down and the H-block plate 710 and the one or more backing plates 718 are pulled together and lock the support plate 702 in place. The embodiment depicted in FIGS. 16-19 include circular clearance holes 708. However, non-circular holes, such as racetrack shaped holes can also be utilized, thus creating even further adjustment capability.

[0057] In another embodiment of the present disclosure, a method of adjusting a location of an inlet to a transition duct in a gas turbine engine is provided in FIG. 20. This method 1100, may be performed utilizing a fixture simulating known positions of the turbine inlet and a combustor, such that the transition ducts are properly configured prior to being installed in a gas turbine engine. In a step 1102, a transition duct is provided for coupling a combustion system to an inlet of a turbine. The transition duct has a support plate secured to an inlet ring of a transition duct, where the support plate comprises a slot and a plurality of clearance holes, an H-block plate having a leg portion and a plurality of first holes, and one or more backing plates each having a second hole.

[0058] In a step 1104, an outlet end of the transition duct is positioned relative to a turbine inlet. Then, in a step 1106, a second mounting mechanism is secured to support the

inlet end or inlet ring of the transition duct. This second mounting mechanism can be a bullhorn bracket, as discussed above. In a step 1108 the H-block plate is slid through the slot in the support plate. One or more backing plates are placed against the support plate in a step 1110 and in a step 1112 the transition duct and support plate are adjusted in position relative to the H-block plate and one or more backing plates such that the transition duct is properly aligned at its inlet end relative to a known position for the combustion system. In a step 1114, a fastener is placed through a first hole, a clearance hole, and a second hole such that the H-block plate and the one or more backing plates contact the support plate and are secured together.

[0059] Although various embodiments of this disclosure have been disclosed, a worker of ordinary skill in this art would recognize that certain modifications would come within the scope of this disclosure. For that reason, the following claims should be studied to determine the true scope and content of this disclosure. Since many possible embodiments may be made of the disclosure without departing from the scope thereof, it is to be understood that all matter herein set forth or shown in the accompanying drawings is to be interpreted as illustrative and not in a limiting sense.

[0060] From the foregoing, it will be seen that this disclosure is one well adapted to attain all the ends and objects hereinabove set forth together with other advantages which are obvious, and which are inherent to the structure.

[0061] It will be understood that certain features and subcombinations are of utility and may be employed without reference to other features and subcombinations. This is contemplated by and is within the scope of the claims.

CLAIMS

Having thus described the disclosure, what is claimed is:

1. A guide vane for a compressor discharge plenum comprising:

a guide support system;

a first side panel and a second side panel; and,

a deflector panel secured to the mounting system and extending between the first side panel and the second side panel, the deflector panel having a curved profile substantially in accordance with Cartesian coordinate values of X, Y, and Z set forth in Table 1 wherein the X, Y, and Z values are in inches from a center point of a bottom surface of the deflector panel, and when connected by smooth continuing arcs, define profile sections of the deflector panel, which when joined smoothly with one another form the curved profile.

2. The guide vane of claim 1 forming a flow path in the compressor discharge plenum between a compressor and a combustor of a gas turbine engine.

3. The guide vane of claim 2, wherein the guide vane directs compressed air from the compressor to cool a transition duct and the combustor.

4. The guide vane of claim 1 further comprising a mounting system for mounting the guide vane to a compressor discharge case.

5. The guide vane of claim 4, wherein the mounting system is coupled to a bullhorn bracket, which in turn supports a transition duct.

6. The guide vane of claim 1, wherein the deflector panel is configured to reduce flow separation for air passing through the compressor discharge plenum.

7. The guide vane of claim 1, wherein the deflector panel has a height measured from a midpoint of a lower-most section to an upper most section of approximately 18 inches.

8. The guide vane of claim 1, wherein the deflector panel is fabricated from a stainless steel.

9. A guide vane for a compressor discharge plenum comprising:

a guide support system;

a first side panel and a second side panel; and,

a deflector panel secured to the mounting system and extending between the first side panel and the second side panel, the deflector panel having a curved profile within an envelope of approximately -0.050 to +0.050 inches in a direction normal to any surface location of the curved profile, where the curved profile is substantially in accordance with Cartesian coordinate values of X, Y, and Z set forth in Table 1 wherein the X, Y, and Z values are in inches from a center point of a bottom surface of the deflector panel, and when connected by smooth continuing arcs, define profile sections of the deflector panel, and which when joined smoothly with one another form the curved profile.

10. The guide vane of claim 9 forming a part of the compressor discharge plenum between a compressor and a combustor of a gas turbine engine.

11. The guide vane of claim 10, wherein the guide vane directs compressed air from the compressor to cool a transition duct and the combustor.

12. The guide vane of claim 9 further comprising a mounting system for mounting the guide vane to a compressor discharge case.

13. The guide vane of claim 9, wherein the deflector panel is configured to reduce flow separation for air passing through the compressor discharge plenum.

14. The guide vane of claim 9, wherein the deflector panel has a height measured from a midpoint of a lower-most section to an upper most section of approximately 18 inches.

15. The guide vane of claim 9, wherein the deflector panel is fabricated from a stainless steel.

16. A compressor discharge region of a gas turbine engine comprising:

a compressor discharge case;

a bullhorn bracket coupled to a portion of the compressor discharge case; and,

a guide vane for directing air flow in a compressor discharge plenum comprising a guide support system, a first side panel and a second side panel, and a deflector panel secured to the guide support system and extending between the first side panel and the second side panel, the deflector panel having a curved profile substantially in accordance with Cartesian coordinate values of X, Y, and Z set forth in Table 1 wherein the X, Y, and Z values are in inches from a center point of a bottom surface of the deflector panel, and when connected by smooth continuing arcs, define profile sections of the deflector panel, which when joined smoothly with one another form the curved profile, the guide vane coupled to the bullhorn bracket.

17. The compressor discharge region of claim 16, wherein the bullhorn bracket is also coupled to a transition duct.

18. The compressor discharge region of claim 17, wherein the guide vane further comprises a mounting system coupled to the bullhorn bracket.

19. The compressor discharge region of claim 18, wherein the deflector panel is configured to reduce flow separation for air passing through the compressor discharge plenum.

20. The guide vane of claim 19, wherein the deflector panel is fabricated from a stainless steel and has a height measured from a midpoint of a lower-most section to an upper most section of approximately 18 inches.

5

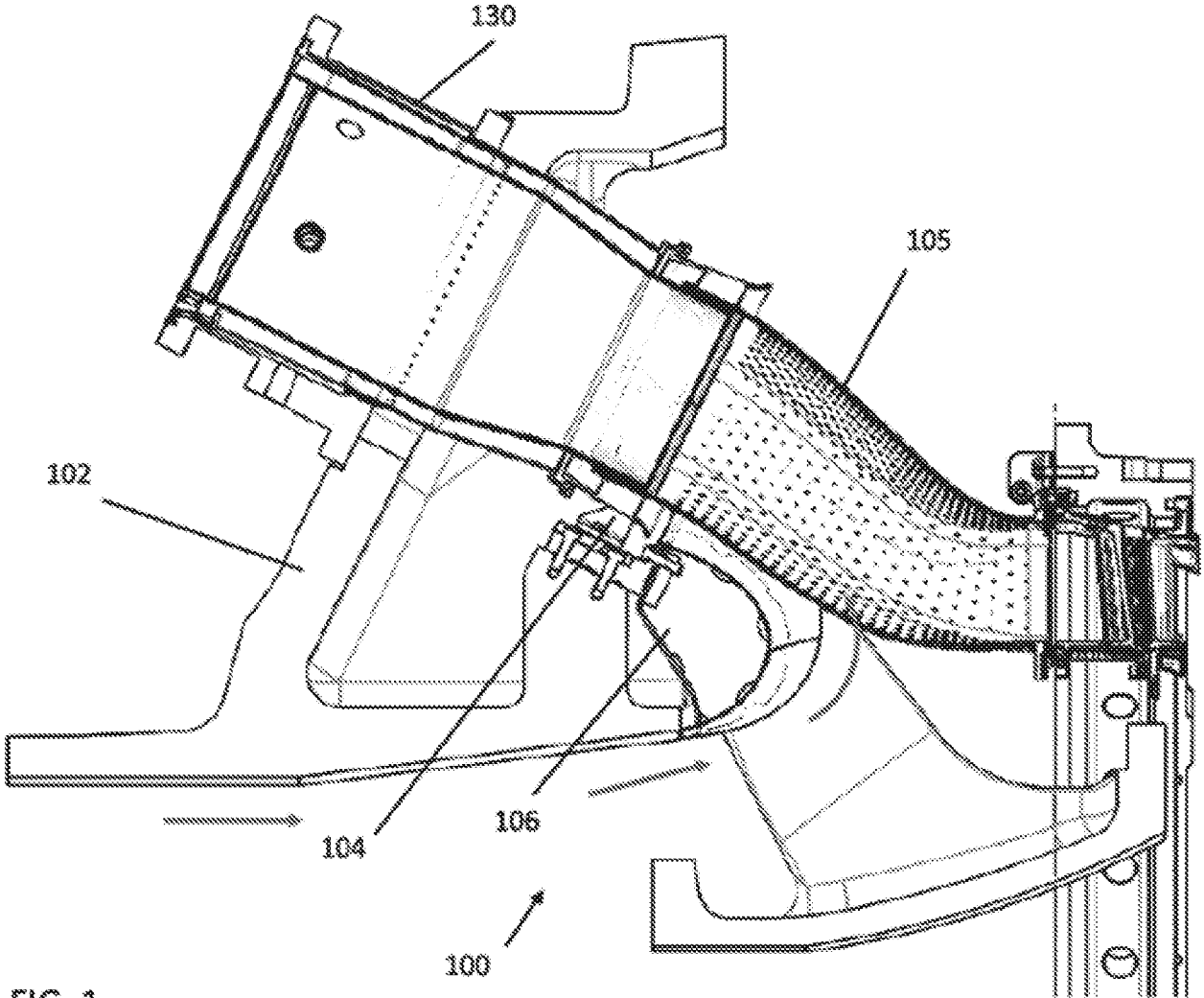

FIG. 1

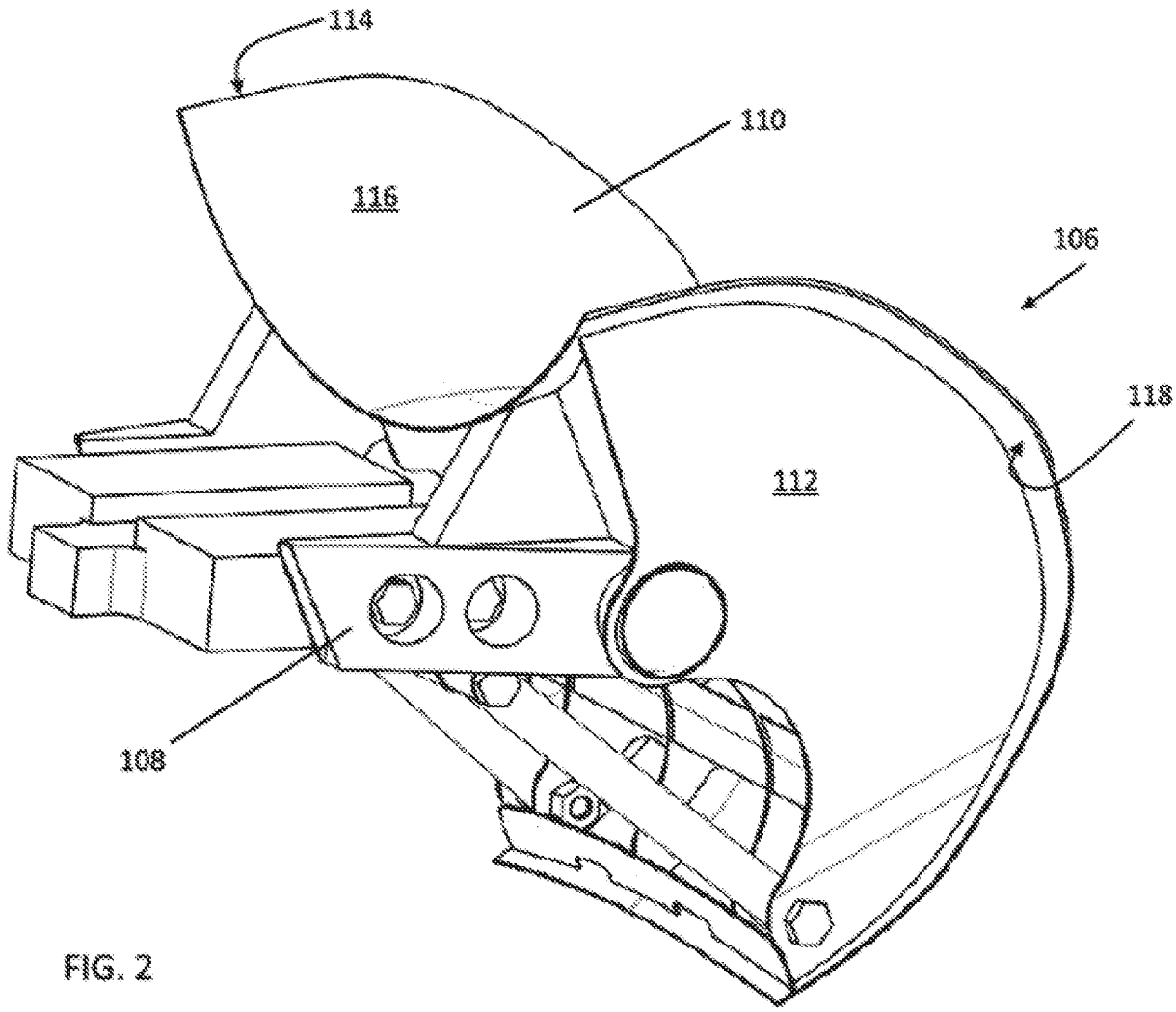

FIG. 2

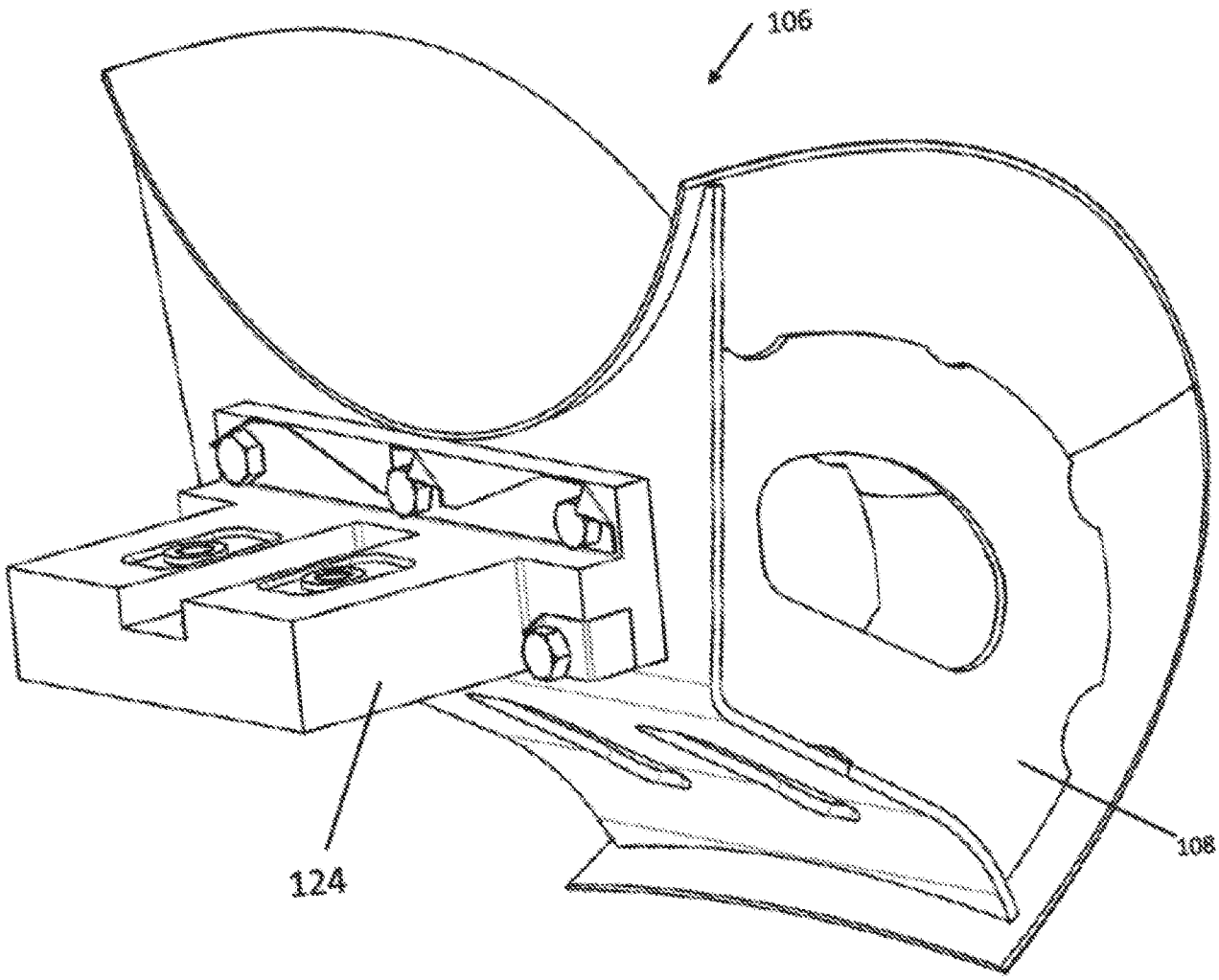

FIG. 3

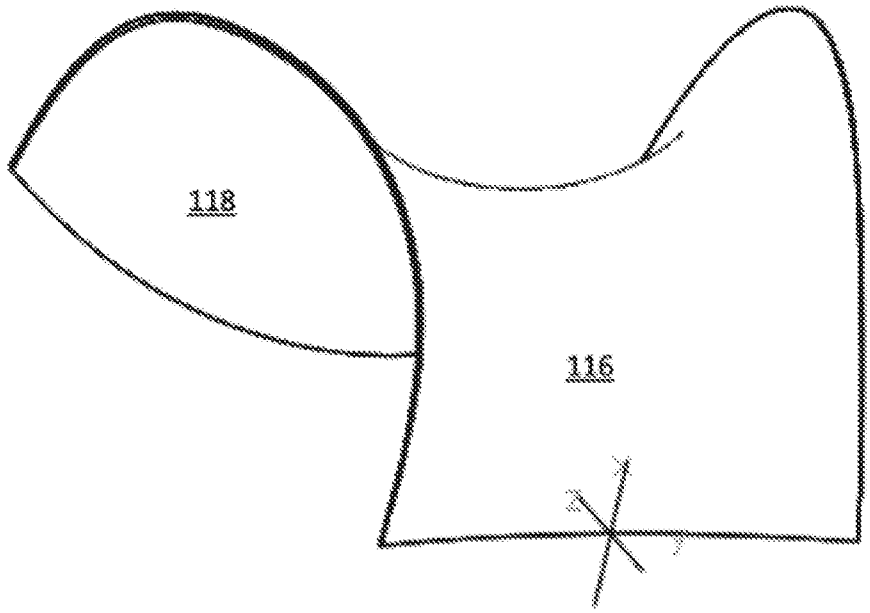

FIG. 4

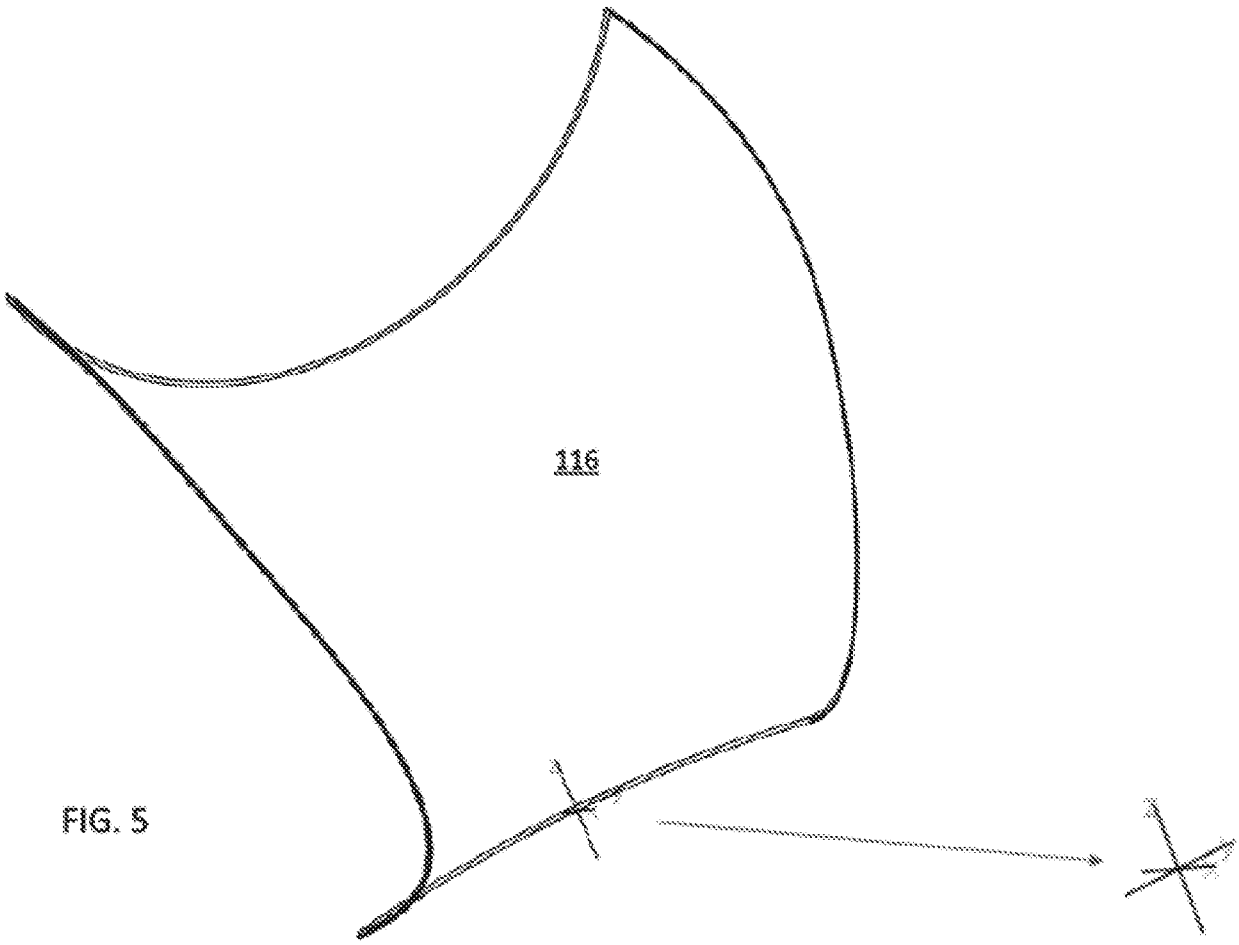

FIG. 5

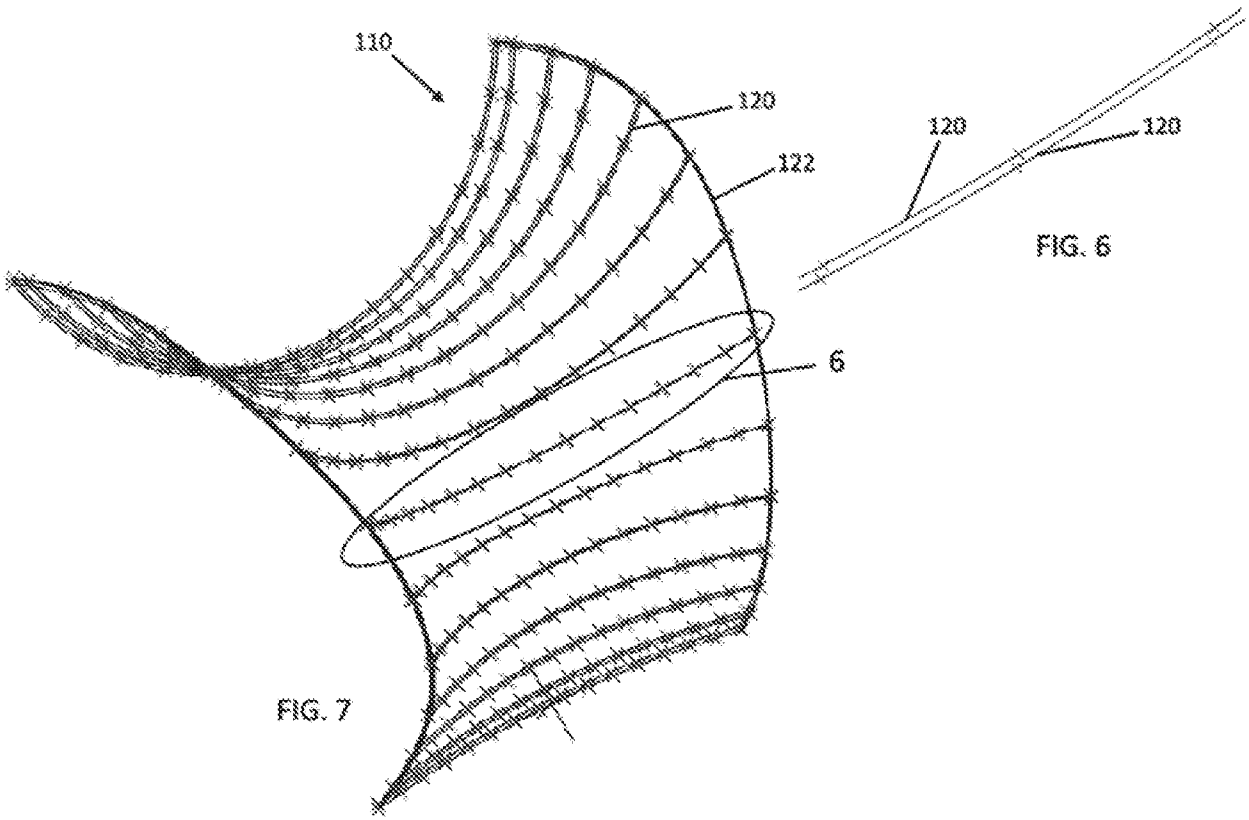

FIG. 7

FIG. 6

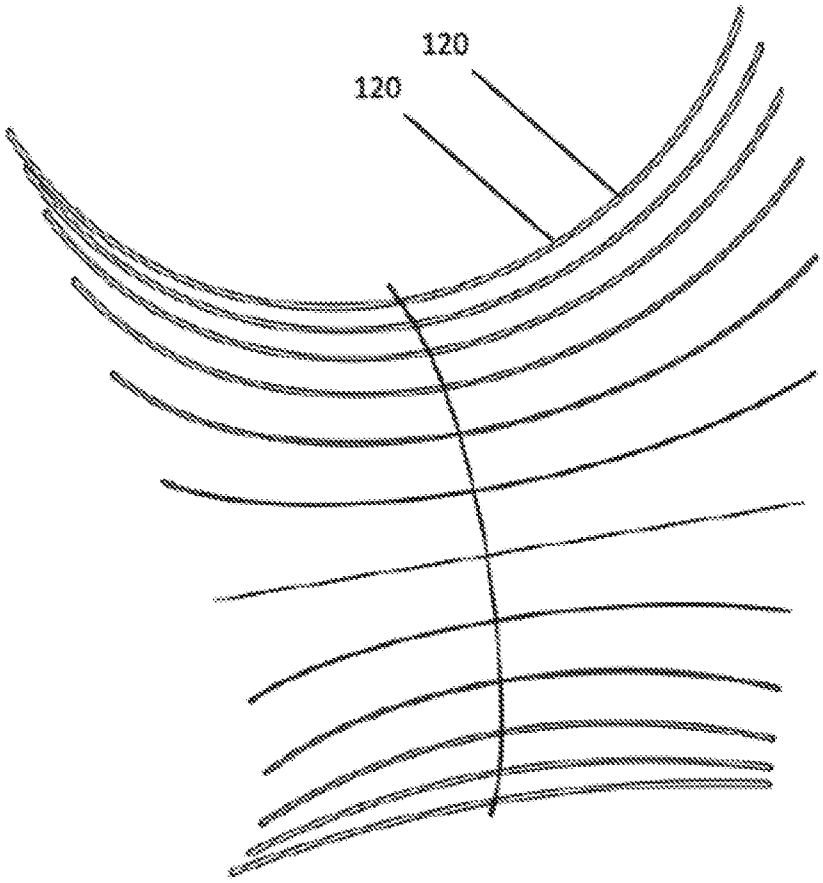

FIG. 8

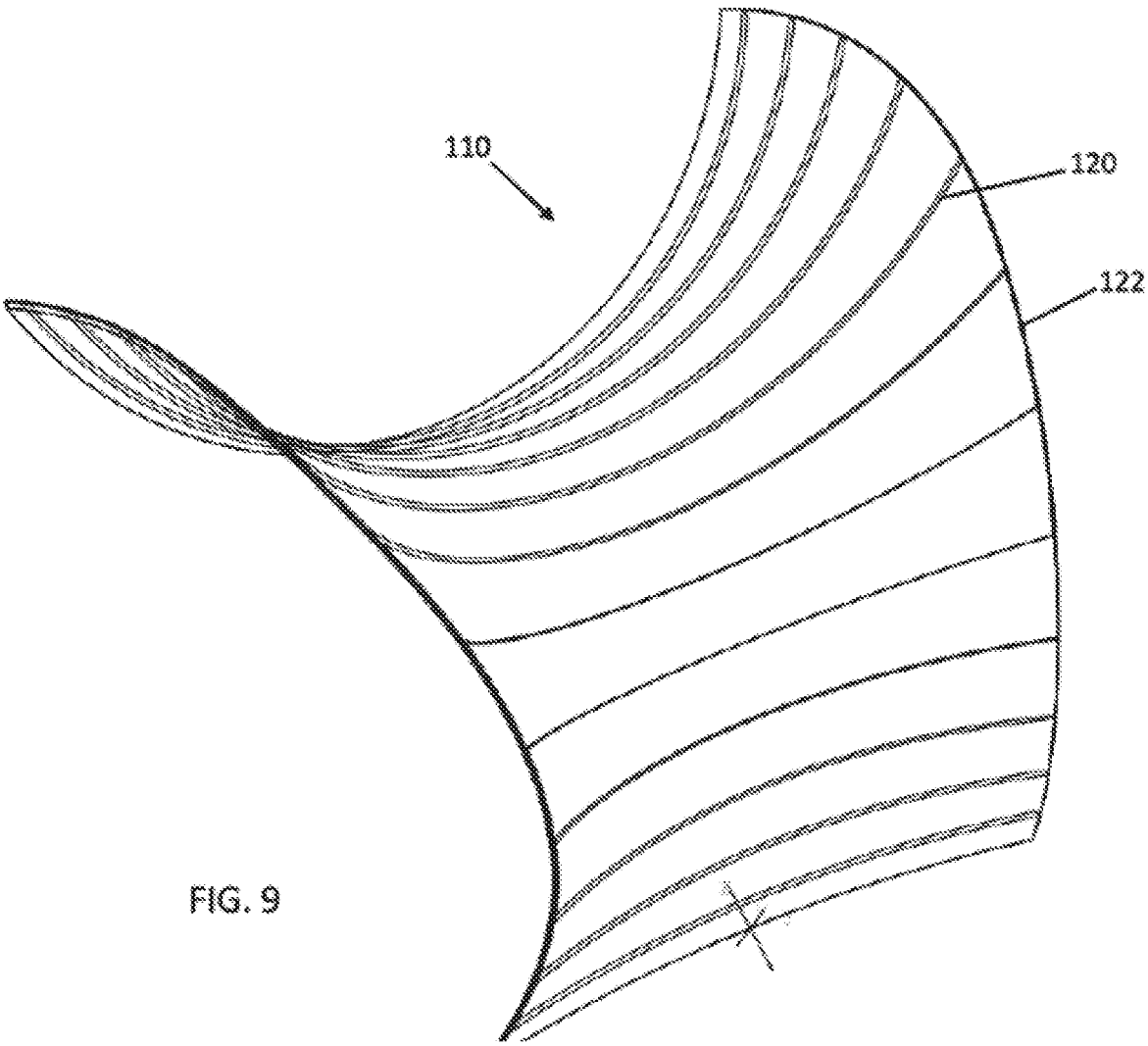

FIG. 9

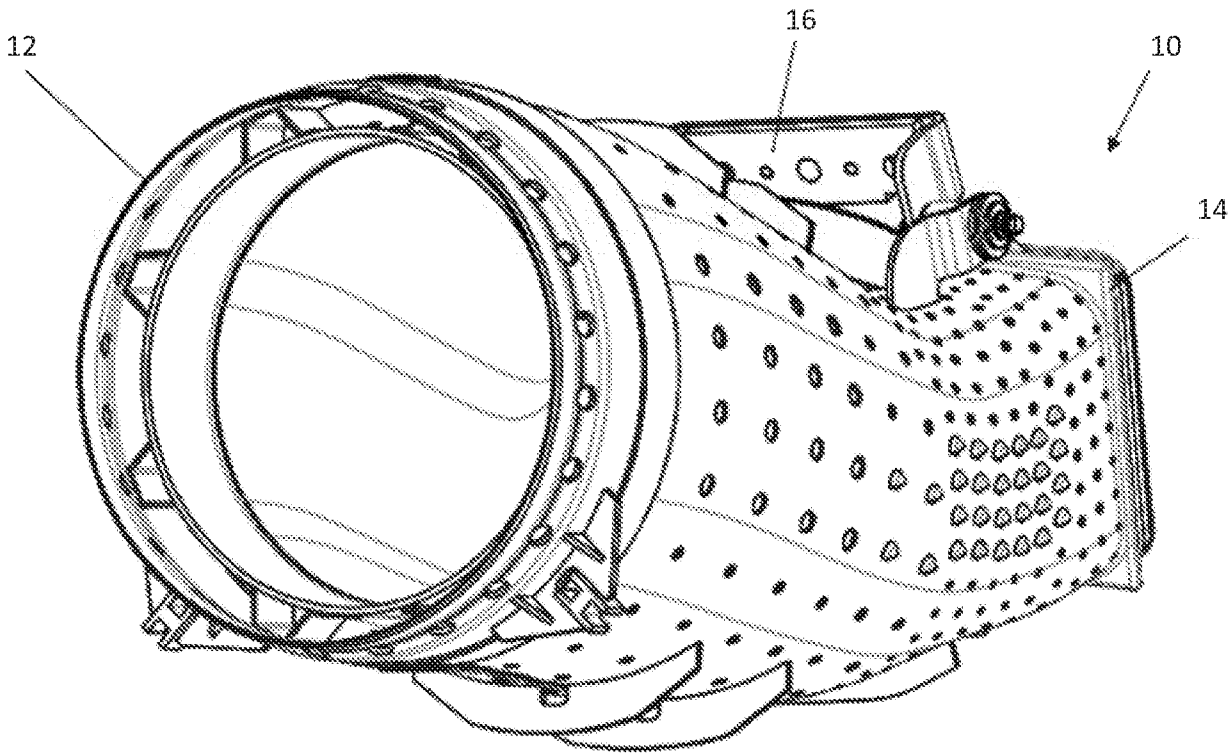

FIG. 10-PRIOR ART

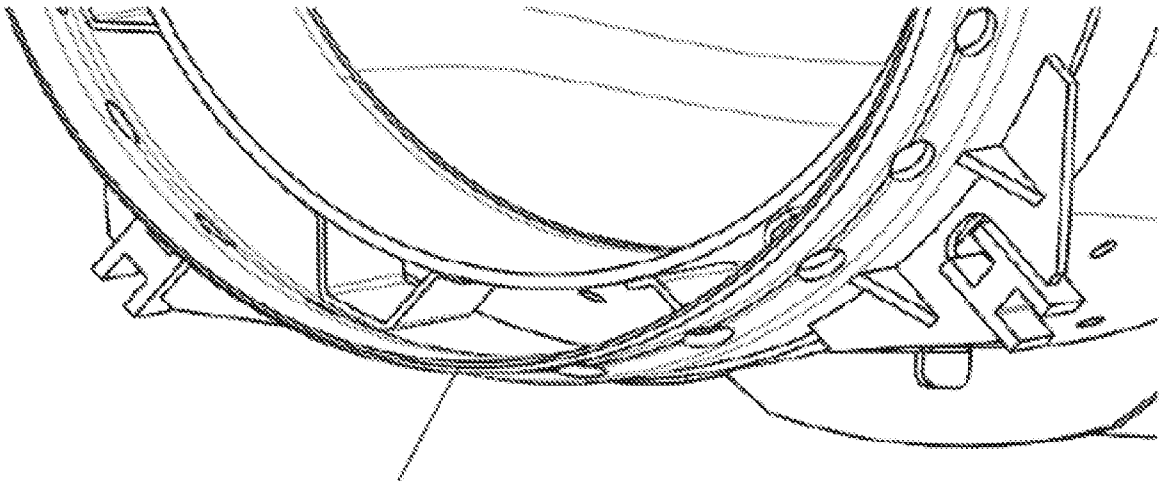

FIG. 11-PRIOR ART

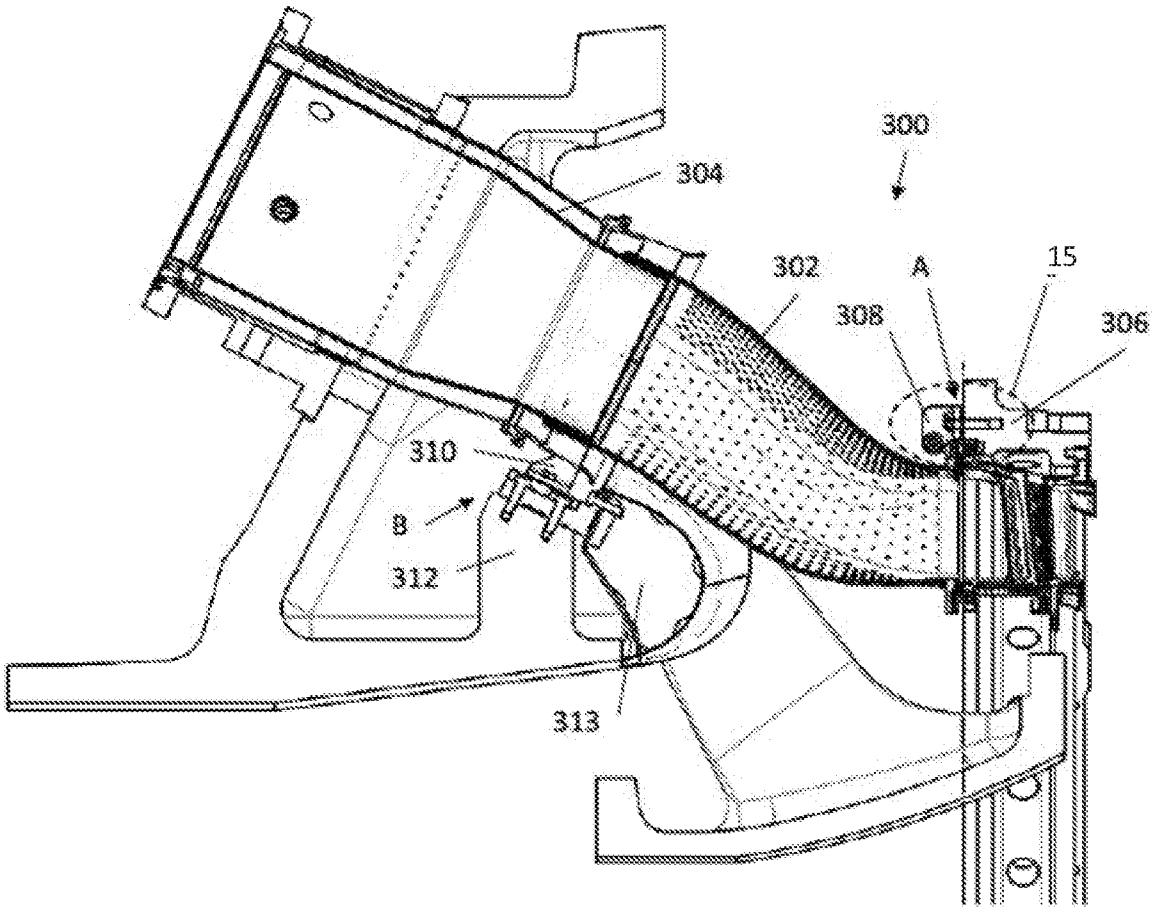

FIG. 12

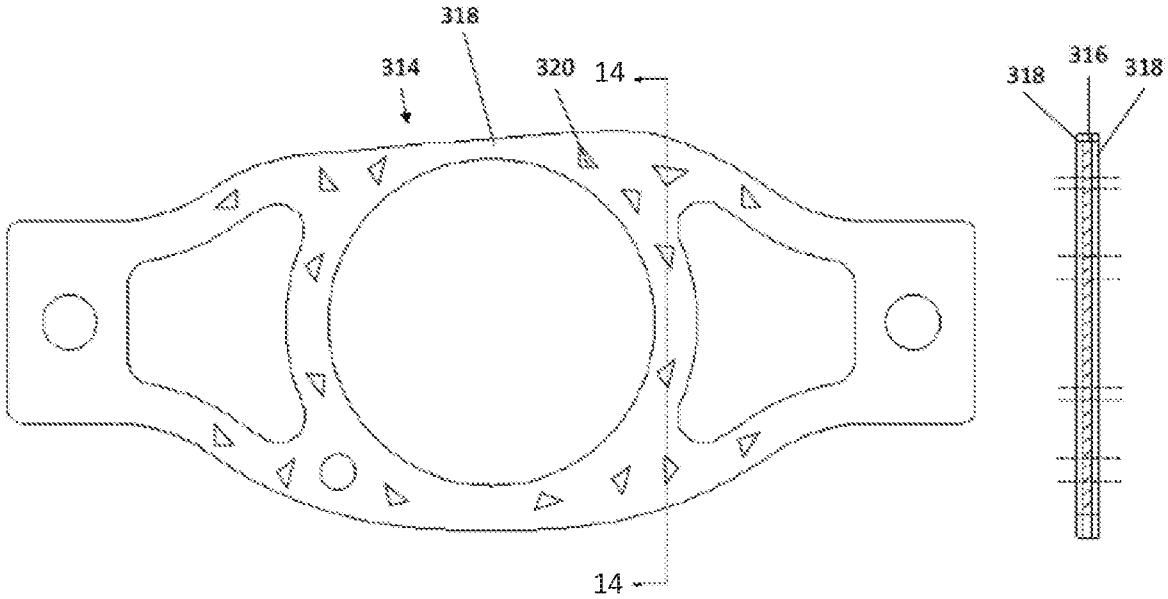

FIG. 14

FIG. 13

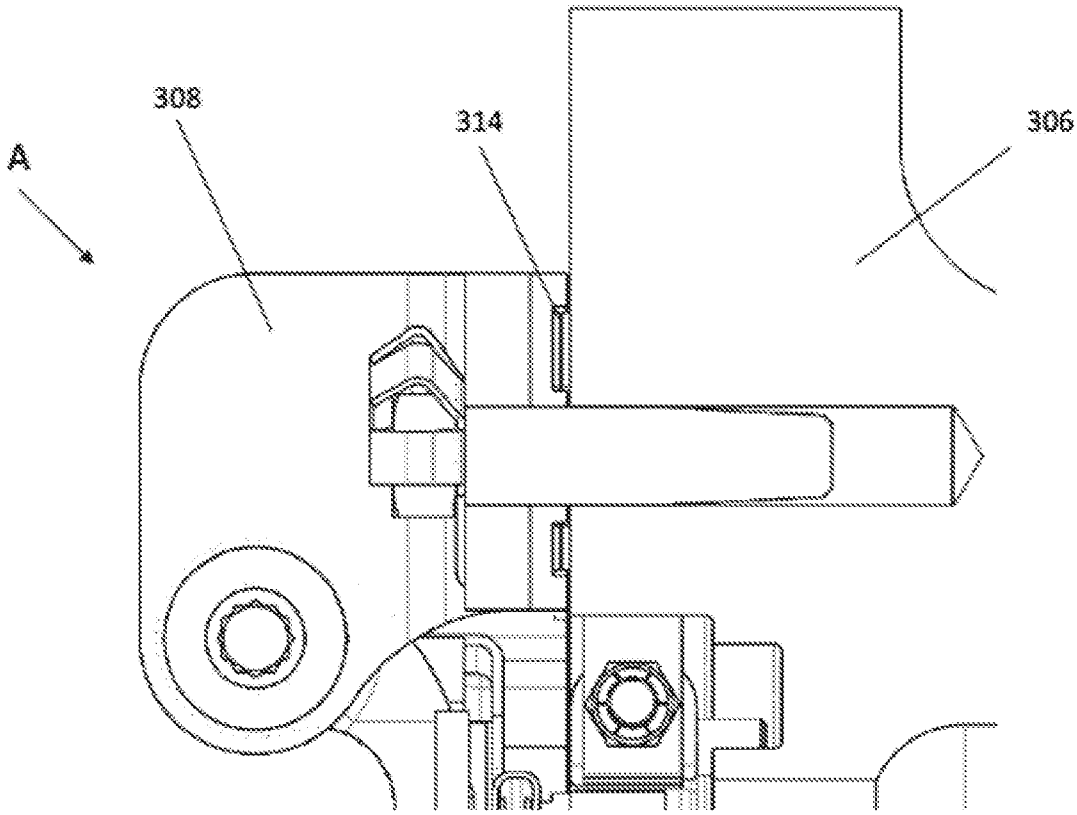

FIG. 15

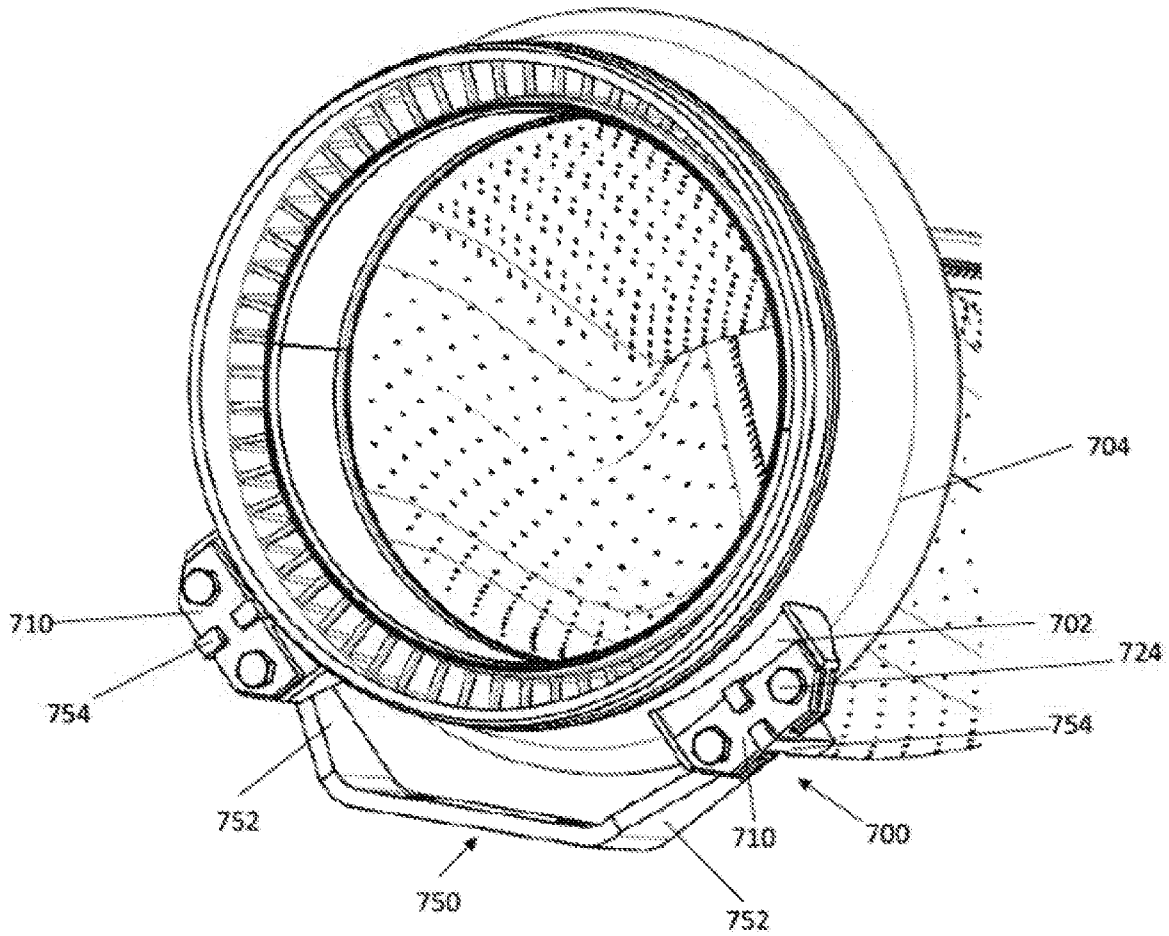

FIG. 16

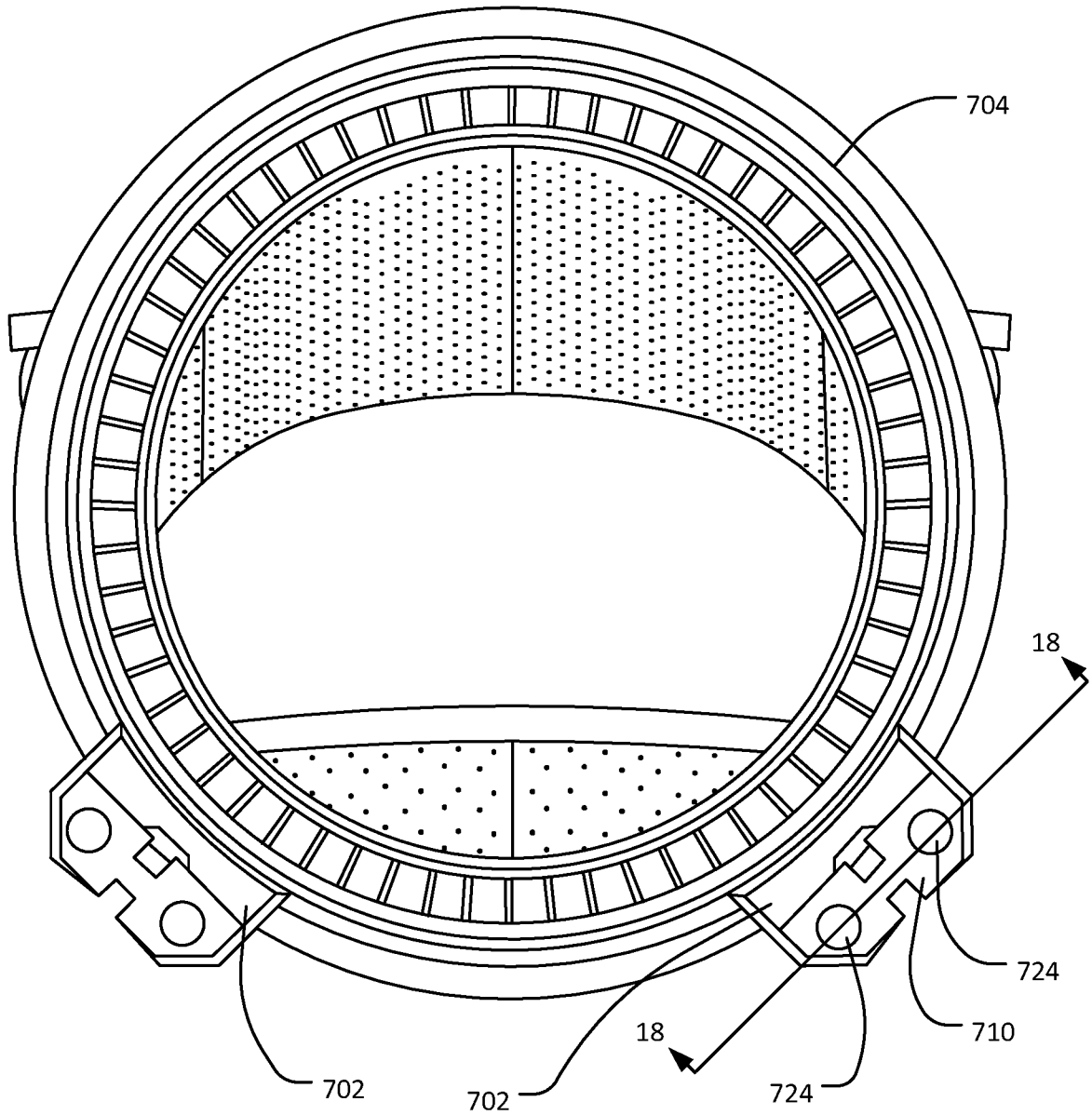

FIG. 17

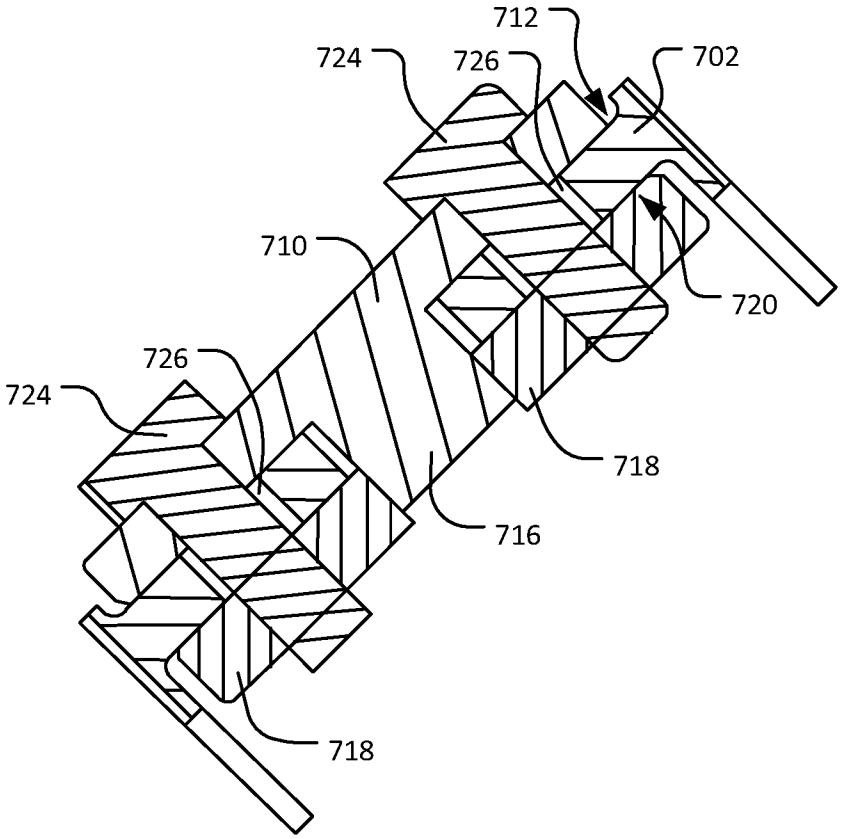

FIG. 18

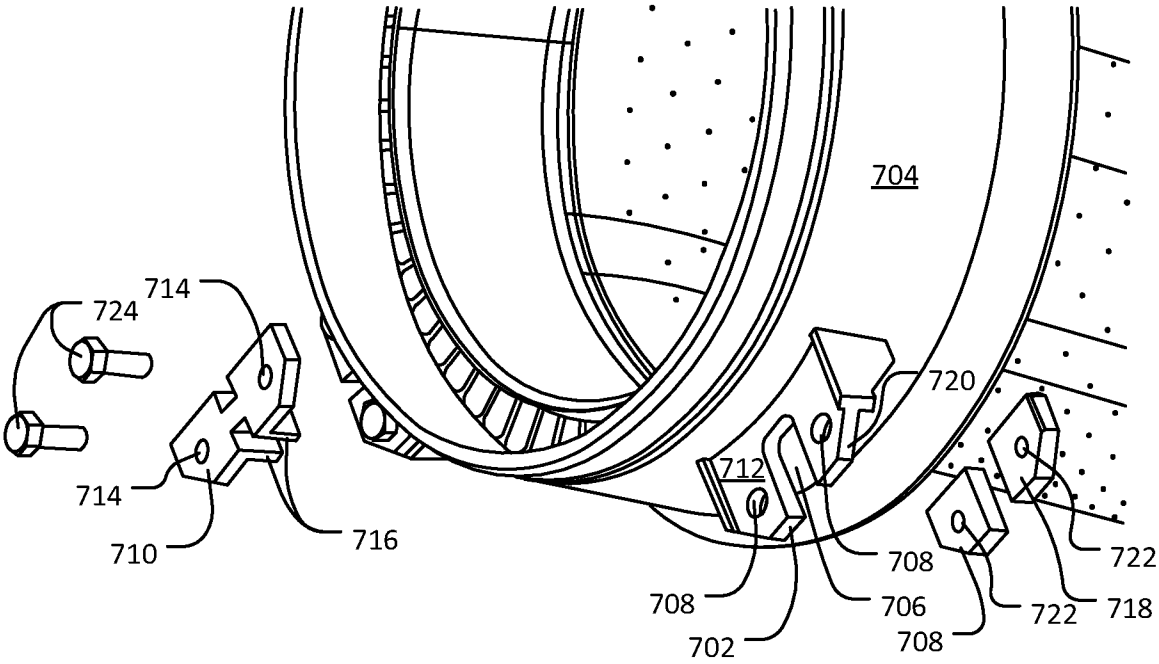

FIG. 19

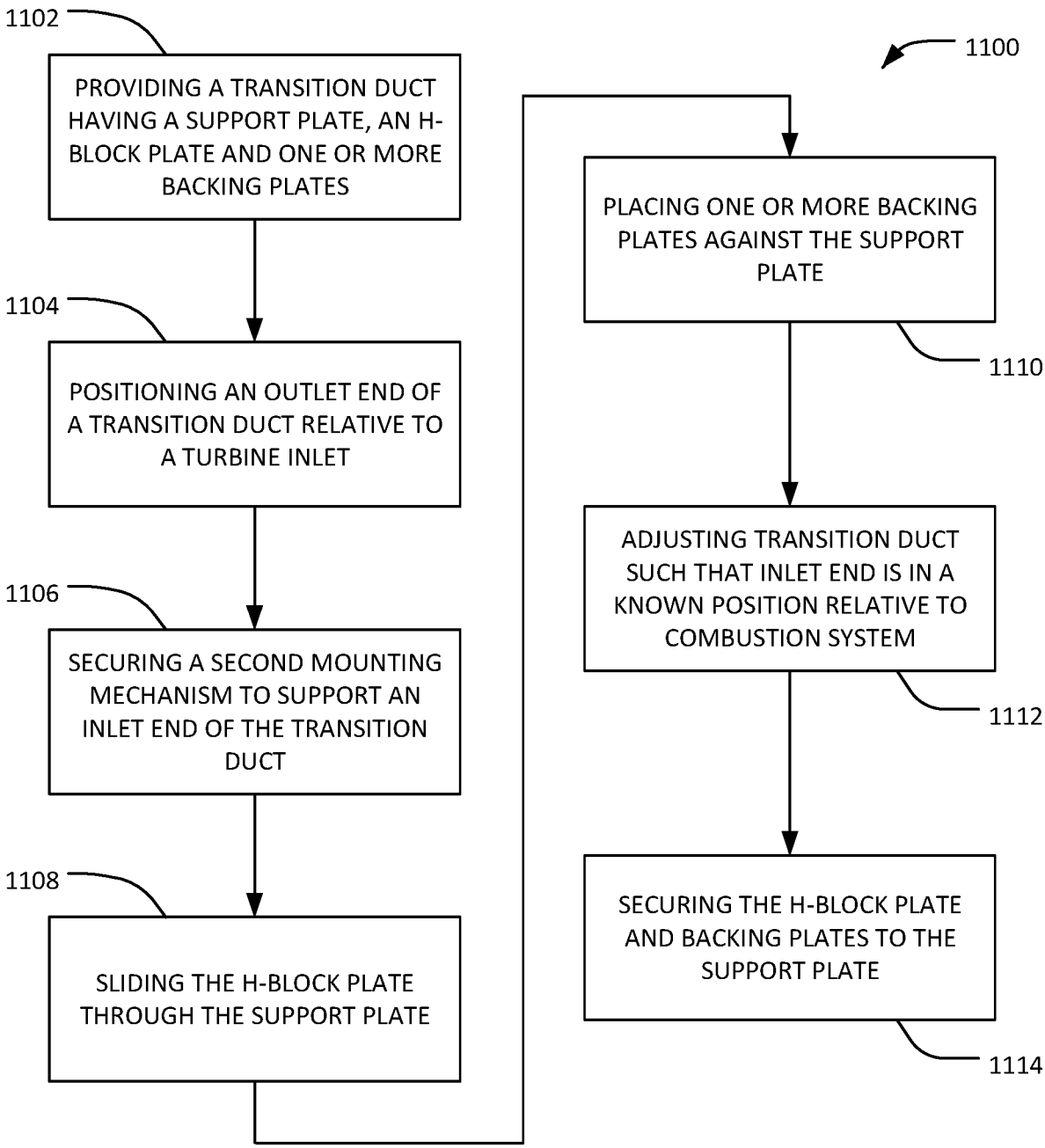
1100
1102
PROVIDING A TRANSITION DUCT HAVING A SUPPORT PLATE, AN H-BLOCK PLATE AND ONE OR MORE BACKING PLATES
1104
POSITIONING AN OUTLET END OF A TRANSITION DUCT RELATIVE TO A TURBINE INLET
1106
SECURING A SECOND MOUNTING MECHANISM TO SUPPORT AN INLET END OF THE TRANSITION DUCT
1108
SLIDING THE H-BLOCK PLATE THROUGH THE SUPPORT PLATE
PLACING ONE OR MORE BACKING PLATES AGAINST THE SUPPORT PLATE
1110
ADJUSTING TRANSITION DUCT SUCH THAT INLET END IS IN A KNOWN POSITION RELATIVE TO COMBUSTION SYSTEM
1112
SECURING THE H-BLOCK PLATE AND BACKING PLATES TO THE SUPPORT PLATE
1114

FIG. 20

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US 19/59387

A. CLASSIFICATION OF SUBJECT MATTER

IPC - F01D 9/04, F04D 29/54, F04D 29/02, F04D 29/64, F04D 19/02, F01D 9/00 (2020.01)

CPC - F04D 29/542, F04D 19/02, F04D 29/023, F04D 29/644

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)
See Search History document

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

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
See Search History document

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X --- Y --- A	US 6,554,569 B2 (Decker et al.) 29 April 2003 (29.04.2003), entire document, especially Figs. 11-2, 4, 6-7; col 3 ln 56-58, 66-67; col 4 ln 1-2, 32-36, col 5 ln 35-36	1-2, 4, 6-7, 9-10, 12-14 --- 8, 15 --- 3, 5, 11, 16-20
Y --- A	US 2018/0023591 A1 (Adjan) 25 January 2018 (25.01.2018), entire document, especially para [0013], [0044]	8, 15 --- 3, 5, 11, 16-20
A	US 2010/0239418 A1 (Schott et al.) 23 September 2010 (23.09.2010), entire document	3, 5, 11, 16-20

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:
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"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
9 April 2020	18 MAY 2020
Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-8300	Authorized officer Lee Young Telephone No. PCT Helpdesk: 571-272-4300