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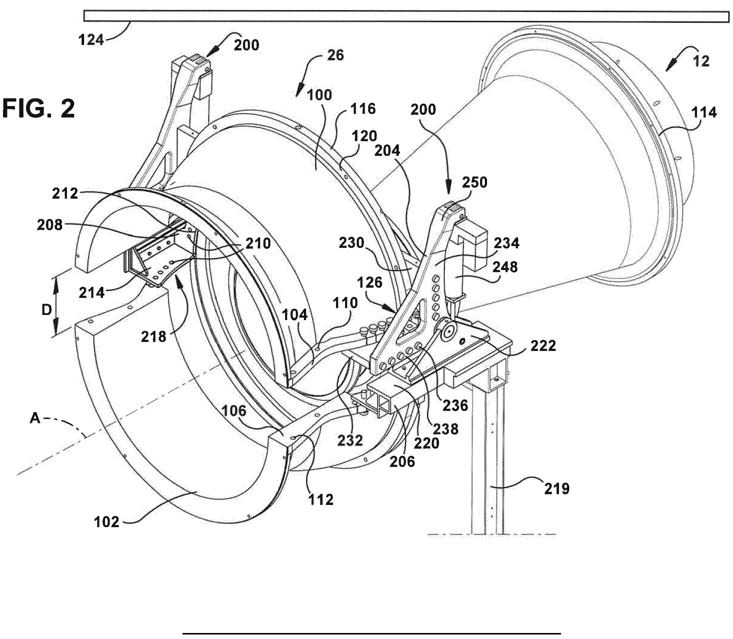
(54) **Apparatus for pivoting an upper portion of a turbine shell**

(57) An apparatus (200) for rotating and positioning a turbine shell (26) of a turbomachine (10) during a maintenance process is provided. The apparatus includes a shell support (204) having a first member (230) and a second member (232) coupled to a side of a vertically upper portion (100) of the turbine shell. The apparatus also includes an actuator (248) coupled to the shell support. The actuator rotates the upper portion of the turbine shell to expose internal components of a turbine system. The apparatus also includes a platform (220) positioned adjacent the shell support and a pivot assembly (222) coupled to the shell support and actuator. The pivot assembly of the apparatus is positioned on a first surface of the platform. Additionally, the apparatus includes a securing structure (206) positioned on a second surface of the platform for preventing movement of the shell support during the rotating of the upper portion of the turbine shell.

FIG. 2



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Description

[0001] The disclosure is related generally to turbomachines. More particularly, the disclosure is related to an apparatus for moving a turbine shell of the turbomachine.

[0002] Conventional turbomachines, such as gas turbine systems, are utilized to generate power for electric generators. In general, conventional turbomachines generate power by passing a fluid (e.g., hot gas) through a compressor and a turbine of the turbomachine. More specifically, fluid may flow through a fluid flow path for rotating a plurality of rotating buckets of the turbine for generating the power. The fluid may be directed through the turbine via the plurality of rotating buckets and a plurality of stationary nozzles positioned between the rotating buckets. These internal components (e.g., buckets, nozzles) may be included within a turbine shell of the turbine. The turbine shell may act as a housing for the internal components and the fluid passing through the turbine during operation of the turbomachine.

[0003] When inspection or maintenance must be performed on the internal components of the turbomachine, the exterior coverings of each portion of the turbomachine (e.g., compressor, turbine) typically must be removed. More specifically, when inspection and/or maintenance must be performed on the internal components (e.g., buckets, nozzles) of the turbine, at least a portion of the turbine shell must be removed to allow operators access to these internal components. In conventional systems, a roof portion of a housing surrounding the turbomachine must be removed in order for a crane to access the turbine shell during a maintenance process. The crane must be capable of lifting the heavy turbine shell from its operational position within the turbomachine, and may remove the turbine shell from the housing via a roof opening, or may place the turbine shell on the floor of the housing, away from the remainder of the turbomachine. A crane capable of moving the heavy turbine shell is very expensive. Additionally, the process of removing a roof portion of the housing surrounding the turbomachine and removing the turbine shell typically takes multiple days. As a result, inspection and/or maintenance of the turbomachine may take multiple weeks to accomplish, where more than a third of the inoperable time of the turbomachine is a result of the expensive and labor intensive process of removing the turbine shell from the turbomachine.

[0004] An apparatus for moving a turbine shell of a turbomachine is disclosed. In one embodiment, the apparatus includes: a shell support having a first member and a second member coupled to an upper portion of a turbine shell; and an actuator coupled to the shell support, the actuator for rotating the upper portion of the turbine shell to expose internal components of a turbine system.

[0005] A first aspect of the invention includes an apparatus having: a shell support having a first member and a second member coupled to an upper portion of a turbine shell; and an actuator coupled to the shell support, the actuator for rotating the upper portion of the turbine shell to expose internal components of a turbine system.

[0006] A second aspect of the invention includes a system having: a shell rotating apparatus coupled to opposing sides of an upper portion of a turbine shell, the shell rotating apparatus including: a shell support having a first member and a second member coupled to the upper portion of the turbine shell; and an actuator coupled to the shell support, the actuator for rotating the upper portion of the turbine shell to expose internal components of a turbine system; and a control system operably connected to the actuator of the shell rotating apparatus, the control system configured to control the actuator during the rotating of the upper portion of the turbine shell.

[0007] These and other features of this invention will be more readily understood from the following detailed description of the various aspects of the invention taken in conjunction with the accompanying drawings that depict various embodiments of the invention, in which:

FIG. 1 shows a schematic depiction of a turbomachine, according to various embodiments of the invention.

FIGS. 2 show a perspective view of a portion of a turbomachine including a shell rotating apparatus according to various embodiments of the invention.

FIG. 3 shows an internal perspective view of a shell rotating apparatus according to various embodiments of the invention.

FIG. 4 shows an external perspective view of a shell rotating apparatus according to various embodiments of the invention.

FIG. 5 shows a perspective view of a portion of a turbomachine including a shell rotating apparatus rotating a turbine shell according to various embodiments of the invention.

FIG. 6 shows a perspective view of a portion of a turbomachine including a shell rotating apparatus and maintenance components according to various embodiments of the invention.

[0008] It is noted that the drawings of the invention are not necessarily to scale. The drawings are intended to depict only typical aspects of the invention, and therefore should not be considered as limiting the scope of the invention. In the drawings, like numbering represents like elements between the drawings.

[0009] As described herein, aspects of the invention relate to turbomachines. Specifically, as described herein, aspects of the invention relate to an apparatus for moving a turbine shell of the turbomachine.

[0010] Turning to FIG. 1, a schematic depiction of a turbomachine is shown according to embodiments of the invention. Turbomachine 10, as shown in FIG. 1 may be a conventional gas turbine system. However, it is understood that turbomachine 10 may be configured as any conventional turbine system (e.g., steam turbine system) configured to generate power for an electric generator. As such, a brief description of the turbomachine 10 is provided for clarity. As shown in FIG. 1, turbomachine 10 may include a compressor 12, combustor 14 fluidly coupled to compressor 12 and a gas turbine component 16 fluidly coupled to combustor 14 for receiving a combustion product from combustor 14. Gas turbine component 16 may also be coupled to compressor 12 via shaft 18. Shaft 18 may also be coupled to a generator 20 for creating electricity during operation of turbomachine 10. In an embodiment, as shown in FIG. 1, a turbine housing 21 may substantially surround turbomachine 10 and the components (e.g., compressor 12, turbine component 16) of turbomachine 10.

[0011] During operation of turbomachine 10, as shown in FIG. 1, compressor 12 may take in air and compress the inlet air before moving the compressed inlet air to the combustor 14. Once in the combustor 14, the compressed air may be mixed with a combustion product (e.g., fuel) and ignited. Once ignited, the compressed air-combustion product mixture is converted to a hot pressurized exhaust gas (hot gas) that flows through gas turbine component 16. The hot gas flows through gas turbine component 16, and specifically, passes over a plurality of buckets 22 (e.g., stages of buckets) coupled to shaft 18, and a plurality of stator nozzles 24 coupled to a turbine shell 26 of turbine component 16. The hot gas flows over the plurality of buckets 22 which rotates buckets 22 and shaft 18 of turbomachine 10, respectively. The plurality of stator nozzles 24 may aid in directing the hot gas through turbine component 16, and more specifically, may direct the hot gas from an upstream set of buckets 22 to a downstream set of buckets 22. As shaft 18 of turbomachine 10 rotates, compressor 12 and gas turbine component 16 are driven and generator 20 may create power (e.g., electric current).

[0012] As used herein, the terms "axial" and/or "axially" refer to the relative position/direction of objects along axis A, which is substantially parallel with the axis of rotation of turbomachine 10 (in particular, the rotor section). As further used herein, the terms "radial" and/or "radially" refer to the relative position/direction of objects along axis (r), which is substantially perpendicular with axis A and intersects axis A at only one location. Additionally, the terms "circumferential" and/or "circumferentially" refer to the relative position/direction of objects along a circumference which surrounds axis A but does not intersect the axis A at any location.

[0013] Turning to FIG. 2, a perspective view of a portion of turbomachine 10 including a shell rotating apparatus is shown according to various embodiments of the invention. In an embodiment, as shown in FIG. 2, turbine shell 26 of turbomachine 10 (FIG. 1) may include an upper portion 100 and a lower portion 102. During operation of turbomachine 10 (FIG. 1), upper portion 100 may be coupled to lower portion 102 in order to form turbine shell 26 of turbomachine 10 (FIG. 1). More specifically, horizontal flange 104 of upper portion 100 and horizontal flange 106 of lower portion 102 may be coupled to form turbine shell 26. In an embodiment, as shown in FIG. 2, horizontal flange 104 of upper portion 100 may include a plurality of openings 110, and horizontal flange 106 of lower portion 102 may include a plurality of openings 112. The plurality of openings 110 of upper portion 100 may be in alignment with the plurality of openings 112 of lower portion 102 when horizontal flange 104 of upper portion 100 and horizontal flange 106 of lower portion 102 contact one another. During operation, each of the plurality of openings 110, 112 may be configured to receive a fastening component (e.g., bolt, threaded fastener, cotter pin, etc.), not shown, for coupling upper portion 100 to lower portion 102. Upper portion 100 may be coupled to lower portion 102 of turbine shell 26 by any conventional mechanical coupling technique including, but not limited to, welding, brazing, snap-fit, slot-fit, bolt, rivet, etc. During operation of turbomachine 10 (FIG. 1), upper portion 100 may be coupled to lower portion 102 to form turbine shell 26, which may provide internal components (e.g., stator nozzles 24) to turbomachine 10 (FIG. 10), and may provide a continuous housing for hot gas to flow through gas turbine component 16 (FIG. 1).

[0014] Additionally, during operation of turbomachine 10 (FIG. 1) turbine shell 26 may be coupled to compressor casing 114 of compressor 12 (FIG. 1). More specifically, as shown in FIG. 2, upper portion 100 of turbine shell 26 may include a vertical flange 116, which may be coupled to a vertical flange 118 of compressor casing 114. In an embodiment, as shown in FIG. 2, vertical flange 116 may be positioned substantially adjacent to, and perpendicular to horizontal flange 104 of turbine shell 26. As shown in FIG. 2, vertical flange 116 of upper portion 100 may include a plurality of apertures 120, and vertical flange 118 of compressor casing 114 may also include a plurality of apertures 122. The plurality of apertures 120 of upper portion 100 may be in alignment with the plurality of apertures 122 of compressor casing 114 when vertical flange 116 of upper portion 100 and vertical flange 118 of compressor casing 114 are in substantial contact. During operation, each of the plurality of apertures 120, 122 may be configured to receive a fastening component (e.g., bolt, threaded fastener, cotter pin, etc.), not shown, for coupling upper portion 100 to compressor casing 114. Upper portion 100 of turbine shell 26 may be coupled to compressor casing by any conventional mechanical coupling technique now known, or later developed. During operation of turbomachine 10 (FIG. 1) upper portion 100 of turbine shell 26 may be coupled to compressor casing 114 of compressor 12 to provide internal components (e.g., stator nozzles 24) to turbomachine 10 (FIG. 1) and provide a continuous housing for hot gas to flow through turbomachine 10.

[0015] When a maintenance process must be performed on turbomachine 10 (FIG. 1), turbomachine 10 must be powered down and, at least partially disassembled for inspection and/or maintenance of the internal component (e.g., buckets 22) of turbomachine 10. More specifically, when a maintenance process must be performed on turbine component 16 of turbomachine 10 (FIG. 1), upper portion 100 of turbine shell 26 must be removed from turbomachine 10. As discussed herein, shell rotating apparatus 200, as shown in FIGS. 2-5, may remove upper portion 100 of turbine shell 26 from turbomachine 10, without removing a roof portion 124 of turbine housing 21 (FIG. 1).

[0016] Once turbomachine 10 (FIG. 1) is powered down, a maintenance process may be performed on turbomachine, and specifically, turbine component 16 (FIG. 1). Preliminarily, upper portion 100 of turbine shell 26 may be uncoupled from turbomachine 10 (FIG. 1). Specifically, upper portion 100 of turbine shell 26 may be uncoupled from lower portion 102 of turbine shell 26 and compressor casing 114 of compressor 12, respectively. The fastening components, not shown, coupling the horizontal flanges 104, 106 of upper portion 100 and lower portion 102, and the fastening components, not shown, coupling the vertical flanges 116, 118 of upper portion 100 and compressor casing 114 may be removed.

[0017] After removing the fastening components (not shown) coupling upper portion 100 to lower portion 102 and compressor casing 114, respectively, upper portion 100 of turbine shell 26 may be positioned substantially above and separate from lower portion 102 of turbine shell 26. More specifically, as shown in FIG. 2, upper portion 100 of turbine shell 26 may be lifted above lower portion 102 of turbine shell to a predetermined distance (D), such that the plurality of openings 104 positioned on horizontal flange 110 of upper portion 100 may remain in substantial alignment with the plurality of openings 112 on horizontal flange 106 of lower portion 102. Predetermined distance (D) may be, at least in part, dependent upon the height of compressor casing 114. More specifically, upper portion 100 of turbine shell 26 may be positioned above and separate from lower portion 100 a predetermined distance (D), which may allow upper portion 100 to be rotated and positioned substantially above compressor casing 114 and substantially below roof portion 124, as discussed herein. Upper portion 100 may be positioned above and separate from lower portion 102 of turbine shell 26 by any conventional mechanical lift mechanism including, but not limited to, a hydraulic lift, a stanchion-style support, a pneumatic actuator, internal crane of turbomachine 100 (FIG. 1), etc.

[0018] After upper portion 100 of turbine shell 26 is positioned substantially above and separated from lower portion 102 of turbine shell 26, a shell rotating apparatus 200 may be coupled to each opposing side 126 of upper portion 100 of turbine shell 26. More specifically, as shown in FIG. 2, shell rotating apparatus 200 may be coupled to each opposing side 126 of upper portion 100 of turbine shell 26, adjacent horizontal flange 104 and vertical flange 116 of upper portion 100. As discussed herein, shell rotating apparatus 200 may be utilized during a maintenance process being performed on turbomachine 10 (FIG. 1) to rotate and position upper portion 100 substantially above compressor casing 114.

[0019] As shown in FIG. 2, and with reference to FIGS. 3 and 4, shell rotating apparatus 200 may include a base 202, and a shell support 204 coupled to base 202. In an embodiment, as shown in FIGS. 2 and 3, base 202 may include a securing structure 206 for substantially preventing movement of shell rotating apparatus 200 during rotation of upper portion 100 of turbine shell 26, as discussed herein. As shown in FIGS. 2 and 3, securing structure 206 may include a first component 208 positioned substantially vertical with respect to axis (A) of rotation. That is, first component 208 may be substantially parallel with vertical flange 118 of compressor casing 114. As shown in FIGS. 2 and 3, first component 208 may include a plurality of mounting holes 210 formed through first component 208. As shown in FIG. 2, the plurality of mounting holes 210 of first component 208 of securing structure 206 may be substantially aligned with the plurality of apertures 122 formed on compressor casing 114 of compressor 12. The plurality of mounting holes 210 of first component 208 of securing structure 206 and the plurality of apertures 122 of compressor casing 114 may be configured to receive a fastening component (e.g., bolt, threaded fastener, cotter pin, etc.), not shown, in order to couple first component 208 of securing structure 206 to compressor casing 114 of compressor 12. As discussed herein, by coupling first component 208 to compressor casing 114, shell rotating apparatus 200 may be made substantially secure or stable (e.g., not move) during the rotation of upper portion 100 of turbine shell 26. In an alternative embodiment, not shown, first component 208 of securing structure 206 may be coupled to compressor casing 114 of compressor 12 by any conventional mechanical coupling technique now known, or later developed.

[0020] First component 208 of securing structure 206, as shown in FIGS. 2 and 3, may also include a substantially curved surface 212 positioned adjacent the plurality of mounting holes 210. Substantially curved surface 212 may include an arc profile substantially similar to the arc profile of compressor casing 114 of compressor 12. More specifically, with reference to FIG. 2, the arc profile of substantially curved surface 212 of first component 208 may be substantially similar and in substantial alignment with the arc profile of a portion of vertical flange 118 of compressor casing 114 coupled to first component 208. As discussed herein, substantially curved surface 212 of first component 208 may prevent obstruction and/or may minimize inaccessibility to certain portions of turbomachine 10 (FIG. 1) when a maintenance process is being performed on turbomachine 10. That is, first component 208 of securing structure 206 may aid in securing shell rotating apparatus 200 to turbomachine 10 (FIG. 1) without substantially obstructing portions of turbomachine 10 while a maintenance process is being performed on turbomachine 10. However, it is understood that first component 208 of securing structure 206 may not require substantially curved surface 212. More specifically, first component 208 may include a substantially polygonal (e.g., rectangular) configuration, wherein a portion of first component structure 208 may extend beyond the portion of vertical flange 118 of compressor casing 114 coupled to first component 208.

[0021] Also shown in FIGS. 2 and 3, securing structure 206 may include a second component 214 positioned substantially horizontal with respect to axis (A) of rotation. As shown in FIGS 2 and 3, second component 214 of securing structure 206 may be substantially parallel with horizontal flange 106 of lower portion 102 of turbine shell 26, and may be positioned substantially perpendicular to first component 208. In an embodiment, as shown in FIGS. 2 and 3, second component 214 may include a plurality of mounting holes 216 formed through second component 214. As shown in FIG. 2, the plurality of mounting holes 216 may be substantially aligned with the plurality of openings 112 on lower portion 102 of turbine shell 26. The plurality of mounting holes 216 of second component 214 of securing structure 206 and the plurality of openings 112 of lower portion 102 may be configured to receive a fastening component (e.g., bolt, threaded fastener, cotter pin, etc.), not shown, in order to couple second component 214 of securing structure 206 to lower portion 102 of turbine shell 26. In an alternative embodiment, not shown, second component 214 of securing structure 206 may be coupled to lower portion 102 of turbine shell 26 by any conventional mechanical coupling technique now known, or later developed.

[0022] Second component 214 of securing structure 206, as shown in FIGS. 2 and 3, may also include a substantially curved surface 218 positioned opposite platform 150 of shell rotating apparatus 200. Substantially curved surface 218 may include an arc profile substantially similar to the arc profile of lower portion 102 of turbine shell 26. More specifically, with reference to FIG. 2, the arc profile of substantially curved surface 218 of second component 214 may be substantially similar and in substantial alignment with the arc profile of a portion of horizontal flange 106 of lower portion 102. As discussed herein, second component 214 of securing structure 206 may aid in securing shell rotating apparatus 200 to turbomachine 10 (FIG. 1) and a fixed mounting, and substantially curved surface 218 of second component 214 may prevent obstruction and/or may minimize inaccessibility to certain portions of turbomachine 10 (FIG. 1) when a maintenance process is being performed on turbomachine 10. Similar to first component 208, it is understood that second component 214 of securing structure 206 may not require substantially curved surface 218. More specifically, second component 214 may include a substantially polygonal (e.g., rectangular) configuration, wherein a portion of second component 214 may extend beyond the portion of horizontal flange 106 of lower portion 102 coupled to second component 214.

[0023] As shown in FIG. 2, securing structure 206 of base portion 202 of rotating apparatus 200 may also be coupled to support 219. More specifically, turbomachine 10 (FIG. 1) may include support 219 coupled to a portion of the floor of turbine housing 21 (FIG. 1), and support 219 may extend from the floor adjacent to rotating apparatus 200 for supporting rotating apparatus 200 during the rotation of upper portion 100 of turbine shell 26. Securing structure 206 of base portion 202 may be coupled to support 219 by any conventional coupling technique now know or later developed.

[0024] In an alternative embodiment, not shown, first component 208 and/or second component 214 of securing structure 206 may be coupled to a support base positioned outside of the components (e.g., lower portion 102, compressor casing 114) of turbomachine 10 (FIG. 1). That is, securing structure 206 may be coupled to a support base positioned adjacent turbomachine 10 (FIG. 1) for substantially preventing movement of shell support 204 of shell rotating apparatus 200 during the rotation of upper portion 100 of turbine shell 26, as discussed herein. In the alternative embodiment, the support base may be coupled to a portion a floor of turbine housing 21 (FIG. 1). That is, securing structure 206 of shell rotating apparatus 200 may not be coupled to turbomachine 10, and as discussed herein, only the components of shell support 204 may be coupled to upper portion 100 of turbine shell 26. As a result, shell rotating apparatus 200 may be positioned within housing 21 (FIG. 1) during the operation of turbomachine 10, such that during a maintenance process being performed on turbomachine 10, shell rotating apparatus 200 may be readily available to rotate upper portion 100 of turbine shell 26 in a substantially short period of time.

[0025] As shown in FIGS. 2-4, shell rotating apparatus 200 may also include a platform 220, and a pivot assembly 222 positioned on platform 220. As shown in FIGS. 3 and 4, pivot assembly 222 may be positioned on a first surface 224 of platform 220, and securing structure 206 may be positioned on a second surface 226 of platform 220. As shown in FIGS. 3 and 4, platform 220 may form a base for shell support 204 of shell rotating apparatus 200 and pivot assembly 222, respectively. That is, platform 220 may provide a surface (e.g., first surface 224) for mounting pivot assembly 222, and shell support 204 coupled to pivot assembly 222, to be used for rotating upper portion 100 of turbine shell 26 (FIG. 2), as discussed herein. As shown in FIGS. 3 and 4, pivot assembly 222 and securing structure 206 may be positioned on platform 220 by any conventional mechanical coupling technique now known or later developed.

[0026] In an embodiment, as shown in FIGS. 2-4, pivot assembly 222 may be coupled to shell support 204. More specifically, as shown in FIGS. 3 and 4, shell support 204 of shell rotating apparatus 200 may be coupled to pivot assembly 222 via a pivot structure 228 positioned through shell support 204 and coupled to pivot assembly

222. That is, pivot structure 228 may be positioned through shell support 204 and may engage pivot assembly 222 to substantially secure shell support 204 to pivot assembly 222. Pivot assembly 222, and more specifically pivot structure 228, may be configured to allow shell support 204, and upper portion 100 of turbine shell 26 coupled to shell support 204 (FIG. 2), to rotate, as discussed herein.

[0027] As shown in FIGS. 2-4, shell support 204 of shell rotating apparatus 200 may include a first member 230 and a second member 232. In an embodiment, as shown in FIGS. 2-4, shell support 204 may include a substantially polygonal body structure having a first portion 234 positioned substantially vertical with respect to axis (A) of rotation. First member 230 of shell support 204 may be coupled to first portion 234. More specifically, as shown in FIGS. 2-4, first member 230 may be coupled to first portion 234 of shell support 204 by a plurality of threaded fasteners 236 positioned through first portion 234 for engaging and substantially securing first member 230 to shell support 204. In an alternative embodiment, not shown, first member 230 may be coupled to first portion 234 of shell support 204 by any conventional mechanical coupling technique including, but not limited to, welding, brazing, snap-fit, slot-fit, bolt, rivet, etc.

[0028] In an embodiment, as shown in FIGS. 2-4, shell support 204 may also include a second portion 238 positioned substantially adjacent first portion 234. More specifically, as shown in FIGS. 2-4, second portion 238 may be positioned adjacent to first portion 234, and may be positioned substantially parallel with respect to axis (A) of rotation. Second member 232 of shell support 204 may be coupled to second portion 238. More specifically, as shown in FIGS. 2-4, and as similarly discussed with respect to first member 230, second member 232 may be coupled to second portion 238 of shell support 204 by the plurality of threaded fasteners 236 positioned through second portion 238. The plurality of threaded fasteners 236 may substantially engage and secure second member 232 to second portion 238 of shell support 204. In an alternative embodiment, not shown, second member 232 may be coupled to second portion 238 of shell support 204 by any conventional mechanical coupling technique including, but not limited to, welding, brazing, snap-fit, slot-fit, bolt, rivet, etc. Additionally, although first member 230 and second member 232 of shell support 204 are shown as separate components of shell rotating apparatus 200, it is understood that first member 230 and second member 232 and/or shell support 204 may be configured as a single component. It is understood that the shape of shell support 204 may vary from that illustrated in FIGS. 3 and 4.

[0029] As shown in FIG. 2, first member 230 and second member 232 of shell support 204 may be coupled to an upper portion 100 of turbine shell 26. More specifically, as shown in FIG. 2, first member 230 and second member 232 of shell support 204 may be coupled to upper portion 100 of turbine shell 26 after upper portion 100 is positioned above and substantially separate from a lower portion 102 of turbine shell 26. As shown in FIG. 2, first member 230 of shell support 204 may be coupled the plurality of apertures 120 positioned on a vertical flange 116 of upper portion 100 of turbine shell 26. More specifically, as shown in FIG. 2, first member 230 of shell support 204 may be coupled to the plurality of apertures 120 positioned on vertical flange 116 adjacent side 126 of upper portion 100 of turbine shell 26. As shown in FIGS. 3 and 4, first member 230 may include a plurality of mounting holes 240 formed through first member 230, and the plurality of mounting holes 240 may be substantially aligned with the plurality of apertures 120 positioned on vertical flange 116 of upper portion 100 (FIG. 2). The plurality of mounting holes 240 (FIGS. 3 and 4) of first member 230 and the plurality of apertures 120 of upper portion 100 (FIG. 2) may be configured to receive a fastening component (e.g., bolt, threaded fastener, cotter pin, etc.), not shown, in order to couple upper portion 100 of turbine shell 26 to first member 230 of shell support 204. In an alternative embodiment, not shown, upper portion 100 of turbine shell 26 may be coupled to first member 230 of shell support 204 by any conventional mechanical coupling technique now known, or later developed.

[0030] As shown in FIGS. 3 and 4, first member 230 of shell support 204 may also include a substantially curved surface 242 positioned opposite first portion 234 of shell support 204. When coupled to upper portion 100, substantially curved surface 242 of first member 230 may be positioned adjacent vertical flange 116 of upper portion 100 of turbine shell 26. Substantially curved surface 242 may include an arc profile substantially similar to the arc profile of vertical flange 116 of upper portion 100 of turbine shell 26. More specifically, with reference to FIGS. 2-4, the arc profile of substantially curved surface 242 of first member 230 (FIGS. 3 and 4) may be substantially similar and in substantial alignment with the arc profile of a portion of vertical flange 116 of upper portion 100 (FIG. 2) coupled to first member 230. As discussed herein, substantially curved surface 242 of first member 230 may prevent obstruction and/or may minimize inaccessibility to certain portions of turbomachine 10 (FIG. 1) when a maintenance process is being performed on turbomachine 10. However, it is understood that first member 230 of shell support 204 may not require substantially curved surface 242. More specifically, first member 230 may include a substantially polygonal (e.g., rectangular) configuration, wherein a portion of first member 230 may extend beyond the portion of vertical flange 116 of upper portion 100 coupled to first member 230.

[0031] In an embodiment, as shown in FIG. 2, second member 232 of shell support 204 may be coupled to a plurality of openings 110 positioned on a horizontal flange 104 of upper portion 100 of turbine shell 26. More specifically, as shown in FIG. 2, second member 232 of shell support 204 may be coupled to the plurality of openings 110 positioned on horizontal flange 104 adjacent side

126 of upper portion 100 of turbine shell 26. That is, horizontal flange 104, and specifically the plurality of openings 110 on horizontal flange 104, may be positioned adjacent vertical flange 116 of upper portion 100, such that the respective members (e.g., first member 230, second member 232) of shell support 204 may be coupled to the respective flanges (e.g., vertical flange 116, horizontal flange 104) of upper portion 100 of turbine shell 26. As shown in FIGS. 2-4, second member 232 may include a plurality of mounting holes 244 (FIGS. 3 and 4) formed through second member 232, similar to the plurality of mounting holes 240 formed through first member 230. The plurality of mounting holes 244 may be substantially aligned with the plurality of openings 110 positioned on horizontal flange 104 of upper portion 100 (FIG. 2). The plurality of mounting holes 244 (FIGS. 3 and 4) of second member 232 and the plurality of openings 110 of upper portion 100 (FIG. 2) may be configured to receive a fastening component (e.g., bolt, threaded fastener, cotter pin, etc.), not shown, in order to couple upper portion 100 of turbine shell 26 to second member 232 of shell support 204. In an alternative embodiment, not shown, upper portion 100 of turbine shell 26 may be coupled to second member 232 of shell support 204 by any conventional mechanical coupling technique now known, or later developed.

[0032] Similar to first member 230, second member 232 of shell support 204 may include a substantially curved surface 246 positioned opposite second portion 238 of shell support 204, as shown in FIGS. 3 and 4. When coupled to upper portion 100, substantially curved surface 246 of second member 232 may be positioned adjacent horizontal flange 104 of upper portion 100 of turbine shell 26. Substantially curved surface 246 of second member 232 may include an arc profile substantially similar to the arc profile of horizontal flange 104 of upper portion 100 of turbine shell 26. More specifically, with reference to FIGS. 2-4, the arc profile of substantially curved surface 246 of second member 232 (FIGS. 3 and 4) may be substantially similar and in substantial alignment with the arc profile of a portion of horizontal flange 104 of upper portion 100 (FIG. 2) coupled to second member 232. As discussed herein, substantially curved surface 246 of second member 232 may prevent obstruction and/or may minimize inaccessibility to certain portions of turbomachine 10 (FIG. 1) when a maintenance process is being performed on turbomachine 10. Similar to first member 230, it is understood that second member 232 of shell support 204 may not require substantially curved surface 246. More specifically, second member 232 may include a substantially polygonal (e.g., rectangular) configuration, wherein a portion of second member 232 may extend beyond the portion of horizontal flange 104 of upper portion 100 coupled to second member 232.

[0033] Although shown as single components, it is understood that first member 230 and second member 232 of shell support 204 may be configured as multiple components. More specifically, in an alternative embodiment, not shown, first member 230 and/or second member 232 may be formed from a plurality of distinct components coupled to shell support 204 of shell rotating apparatus 200. In the alternative embodiment, the plurality of components making up first member 230 and/or second member 232 may be positioned along first portion 234 and/or second portion 238, respectively, and may be substantially spaced apart from one another.

[0034] In an embodiment, as shown in FIGS. 2-4, shell rotating apparatus 200 may also include an actuator 248 coupled to shell support 204. As discussed herein, actuator 248 of shell rotating apparatus 200 may be configured to rotate upper portion 100 of turbine shell 26 to expose internal components (e.g., shaft 18, buckets 22, stator nozzles 24) of turbomachine 10 (FIG. 1). As shown in FIGS. 2-4, actuator 248 may be coupled to shell support 204 adjacent first portion 234 and first member 230, respectively. More specifically, as shown in FIGS. 2-4, actuator 248 may be coupled to a first end 250 of shell support 204 positioned substantially above horizontal flange 104 of upper portion 100. Actuator 248, as shown in FIGS. 2-4, may include a conventional mechanical ball screw actuator. However, it is understood that actuator 248 may be selected from a group of any conventional actuators capable of rotating upper portion 100 of turbine shell 26 including, but not limited to, a hydraulic actuator, a pneumatic actuator, mechanical actuator, or an electric actuator.

[0035] Additionally, as shown in FIGS. 3 and 4, pivot assembly 222 may be coupled to actuator 248. More specifically, as shown in FIG. 4, actuator 248 may include a piston 252 coupled to a pin 254 of pivot assembly 222. In coupling piston 252 of actuator 248 to pin 254 of pivot assembly 222, actuator 248 may rotate shell support 102, and upper portion 100 of turbine shell 26 coupled to shell support 102 (FIG. 2), during the actuation of actuator 248. More specifically, as shown in FIG. 5, by constraining piston 252 of actuator 248, during the actuation of actuator 248 where piston 252 retracts into actuator 248, first end 250 of shell support 102 may move with actuator 248 such that first end 250 of shell support 102 is moved closer to lower portion 102 of turbine shell 26 (FIG. 2). Simultaneously, as first end 250 of shell support 102 moves closer to lower portion 102 of turbine shell 26 (FIG. 2), a second end 256 of shell support 102 moves away from lower portion 102 of turbine shell 26. As a result, as shown in FIG. 5, shell support 204, and upper portion 100 of turbine shell 26 may be substantially rotated, and first member 230 of shell support 204 may be substantially horizontal with respect to axis (A) of rotation, and second member 232 of shell support 204 may be substantially vertical with respect axis (A) of rotation. That is, shell support 204 may substantially rotate upper portion 100 of turbine shell 26, for positioning upper portion above compressor 12, as discussed herein, and/or positioning upper portion 100 of turbine shell 26 to be more easily relocated while a maintenance process may be performed on turbine component 16.

[0036] In an embodiment, as shown in FIG. 5, actuator 248 of shell rotating apparatus 200 may rotate upper portion 100 of turbine shell 26 to a range of approximately 80 degrees and approximately 95 degrees from horizontal or axis (A) of rotation. More specifically, actuator 248 of shell rotating apparatus 200 may rotate upper portion 100 of turbine shell 26 approximately 85 degrees from horizontal. As shown in FIG. 5, the rotating of upper portion 100 of turbine shell 26 may include positioning upper portion 100 of turbine shell 26 above compressor casing 114 of compressor 12, within turbine housing 21 (FIG. 1). More specifically, as shown in FIG. 5, upper portion 100 of turbine shell 26 may be rotated and positioned above compressor casing 114 using shell rotating apparatus 200, without having to remove a roof portion 124 of turbine housing 21, as discussed herein.

[0037] Shell rotating apparatus 200, and specifically actuator 248, may rotate upper portion 100 of turbine shell 26 until upper portion 100 substantially engages a support structure 258 positioned adjacent turbine shell 26. More specifically, as shown in FIG. 5, upper portion 100 may be rotated to be positioned above compressor casing 114 and may substantially engage support structure 258 in order to be positioned in a desirable maintenance position prior to performing a maintenance process on turbomachine 10 (FIG. 1). In an embodiment, as shown in FIG. 5, vertical flange 116, now positioned substantially horizontal with respect to axis (A) of rotation, may substantially engage support structure 258. As shown in FIG. 5, support structure 258 may be positioned substantially adjacent shell rotating apparatus 200, turbine shell 26 and compressor casing 114, respectively. In an embodiment, support structure 258 may be positioned on the floor of turbine housing 21 for supporting upper portion 100 of turbine shell 26 after the rotating of upper portion 100 by actuator 248. That is, support structure 258 may provide additional support to upper portion 100 of turbine shell 26, and/or may relief some of the mechanical stress placed on shell rotating apparatus 200 once upper portion 100 of turbine shell 26 is positioned above compressor casing 114. In an alternative embodiment, support structure 258 may be coupled to a component (e.g., compressor casing 114, turbine shell 26) of turbomachine 10 (FIG. 1) for supporting upper portion 100 after rotation.

[0038] As shown in FIGS. 2 and 5, actuator 248 may be operably connected to a control system 260 configured to control actuator 248 during the rotating of upper portion 100 of turbine shell 26, as discussed herein. Control system 260 may be configured as any conventional user-interactive or automated computer system for controlling actuator 248 during the rotating of upper portion 100 of turbine shell 26. That is, control system 260 may include any conventional or standard control system, which may contain at least a portion of computerized features, corresponding with actuator 248 of shell rotating apparatus 200.

[0039] In an embodiment, as shown in FIG. 6, after upper portion 100 of turbine shell 26 has be rotated by shell rotating apparatus 200, maintenance components 300 may be coupled to turbomachine 10 (FIG. 1). More specifically, as shown in FIG. 6, maintenance components 300 may be coupled to upper portion 100 of turbine shell 26 and compressor casing 114 of compressor 12. As shown in FIG. 6, maintenance components 300 may include a platform system 302 coupled to upper portion 100 of turbine shell 26, and a storage rack 303 coupled to compressor casing 114 of compressor 12. Platform system 302 may include a base structure 304 coupled directly to upper portion 100 of turbine shell 26. More specifically, as shown in FIG. 6, base structure 304 may be coupled to horizontal flange 104 of upper portion 100, and both an outer surface 128 and inner surface 130 of upper portion 100 of turbine shell 26. Base structure 304 of platform system 302 may be positioned substantially above vertical flange 116 of upper portion 100, and may include additional supports 308 (shown in phantom) coupled to vertical flange 116 of upper portion 100. Supports 308 may provide additional structural support to platform system 302, however, it is understood that supports 308 may not be required to couple platform system 302 to upper portion 100 of turbine shell 26. In an embodiment, as shown in FIG. 6, base structure 304 may provide a framework for platform system 302, such that a turbine operator performing maintenance on turbomachine 10 (FIG. 1) may walk around rotated upper portion 100 of turbine shell using platform system 302.

[0040] Platform system 302, as shown in FIG. 6, may also include a deck surface 310 coupled to base structure 304. More specifically, deck surface 310 may be positioned substantially over base structure 304 to provide a turbine operator a platform for walking around upper portion 100 of turbine shell 26, and/or providing overhead access to the internal components (e.g., buckets 22) of turbine component 16 (FIG. 1). Deck surface 310 may include any conventional material for providing the turbine operator a flat walkway or platform to walk on including, but not limited to, plywood, sheet metal, rubber matting, etc.

[0041] In an embodiment, as shown in FIG. 6, platform system 302 may also include boundary rails 312 coupled to base structure 304. More specifically, boundary rails 312 may be coupled to base structure 304 opposite upper portion 100 of turbine shell 26 for providing a substantially enclosed work area for platform system 302. Boundary rails 312 may be coupled to base structure 304 by any conventional mechanical coupling technique now known or later developed. Boundary rails 312 may include any conventional substantially vertical framework structure configured to provide a boundary for platform system 302 and/or prevent a user walking on platform system 302 from undesirably leaving deck surface 310.

[0042] As shown in FIG. 6, storage rack 303 of maintenance components 300 may be coupled to compressor casing 114 of compressor 12. More specifically, storage rack 303 may be coupled to compressor casing 114 adjacent upper portion 100 of turbine shell 26 and platform system 302, respectively. Storage rack 303 may include a support frame 314 coupled to an outer surface 132 of compressor casing 114. In an embodiment, as shown in FIG. 6, storage rack 303 may also include a plurality of rack protrusions 316. Each of the plurality of rack protrusions 316 may be positioned substantially perpendicular to support frame 314, and may extend toward platform system 302. The plurality of rack protrusions 316 of storage rack 303 may provide a user on platform system 302, who may be performing a maintenance process on turbomachine 10 (FIG. 1), the ability to temporarily store components of turbomachine 10 (FIG. 1). That is, storage rack 303 may provide a user performing maintenance on turbomachine 10 (FIG. 1) an onsite, temporary storage component for holding internal components (e.g., buckets 22) that may need to be serviced and/or removed from turbine component 16 (FIG. 1) so maintenance may be performed on other components of turbine component 16.

[0043] By utilizing shell rotating apparatus 200 during a maintenance process of turbomachine 10 (FIG. 1), a roof portion 124 of turbine housing 21 (FIG. 1) may not be required to be removed in order to move upper portion 100 of turbine shell 26. That is, shell rotating apparatus 200 may remove upper portion 100 of turbine shell 26 from turbomachine 10, without the need of a conventional overheard crane (not shown). These conventional overheard cranes may require that a roof portion 124 of housing 21 be removed to gain access to upper portion 100 of turbine shell 26, which can be expensive and time consuming. As a result, by utilizing shell rotating apparatus 200, maintenance process may be performed on turbomachine 10 (FIG. 1) with a reduced cost and reduced operational downtime of turbomachine 10, by comparison to conventional processes.

[0044] The material used for shell rotating apparatus 200 may be any combination of material capable of withstanding the weight of upper portion 100 during the rotation process. More specifically, shell rotating apparatus 200, and the respective components (e.g., base portion 202, shell support 204), may be made from any conventional material capable of withstanding the force placed on shell rotating apparatus 200 during the rotating of upper portion 100 including, but not limited to, steel alloys, aluminum alloys, iron alloys, titanium, etc.

[0045] As discussed herein, actuator 248 may include a simple pivot hinge assembly (e.g., piston 252, pin 254) for rotating upper portion 100 of turbine shell 26. However, it is understood that a plurality of conventional pivot assemblies and/or rotating mechanisms may be used with shell rotating apparatus 200. For example, a floating hinge assembly or lift hinge assembly may be utilized by shell rotating apparatus 200 to provide an amount of translational movement when removing upper portion 100 from turbine shell 26.

[0046] Although discussed herein as turbine shell 26 being configured as two portions (e.g., upper portion 100, lower portion 102), it is understood that turbine shell 26 may include a plurality of portions. For example, in an alternative embodiment, turbine shell 26 may be configured in four separate portions. In the alternative embodiment, a single shell rotating apparatus 200 may be coupled to each of the two quarters that form the upper portion 100 of turbine shell 26. As a result, each of the shell rotating apparatus 200 may rotate the individual portions forming upper portion 100 of turbine shell 26 distinct of one another.

[0047] Additionally, it is understood that a single shell rotating apparatus 200 may be utilized for rotating upper portion 100 of turbine shell 26. More specifically, a single shell rotating apparatus 200 may be coupled to a single side 126 of upper portion 100 of turbine shell 26 for rotating upper portion 100 during a maintenance process of turbomachine 10 (FIG. 1). In an embodiment using only one shell rotating apparatus 200, a plurality of support structures 258 may be used with turbomachine 10 to help alleviate the stress placed on the single shell rotating apparatus 200 during the rotating of upper portion 100 of turbine shell 26. That is, the plurality of support structures 258 may substantially support upper portion 100 of turbine shell 26 after upper portion 100 is rotated, which may result in less stress placed on the singe shell rotating apparatus 200 while a maintenance process is being performed on turbomachine 10.

[0048] The terminology used herein is for the purpose of describing particular embodiments only and is not intended to be limiting of the disclosure. As used herein, the singular forms "a", "an" and "the" are intended to include the plural forms as well, unless the context clearly indicates otherwise. It will be further understood that the terms "comprises" and/or "comprising," when used in this specification, specify the presence of stated features, integers, steps, operations, elements, and/or components, but do not preclude the presence or addition of one or more other features, integers, steps, operations, elements, components, and/or groups thereof.

[0049] 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.

[0050] Various aspects and embodiments of the present invention are defined by the following numbered clauses:

1. An apparatus comprising:

a shell support having a first member and a second member coupled to a side of an upper portion of a turbine shell; and

an actuator coupled to the shell support, the actuator for rotating the upper portion of the turbine shell to expose internal components of a turbine system.

2. The apparatus of clause 1, wherein the actuator rotates the upper portion of the turbine shell to a range of approximately 80 degrees and approximately 95 degrees from horizontal.

3. The apparatus of any preceding clause, wherein the actuator is selected from the group consisting of a mechanical ball screw actuator, a hydraulic actuator, a pneumatic actuator, and an electric actuator.

4. The apparatus of any preceding clause, wherein the first member is coupled to a plurality of apertures on a vertical flange of the upper portion of the turbine shell, the plurality of apertures on the vertical flange for coupling the upper portion of the turbine shell to a compressor casing during operation of the turbine system.

5. The apparatus of any preceding clause, wherein the second member is coupled to a plurality of openings on a horizontal flange of the upper portion of the turbine shell, the plurality of openings on the horizontal flange for coupling the upper portion of the turbine shell to a lower portion of the turbine shell during operation of the turbine system.

6. The apparatus of any preceding clause, wherein the first member and the second member are coupled to the upper portion of the turbine shell after the upper portion of the turbine shell is positioned above and separated from the lower portion of the turbine shell.

7. The apparatus of any preceding clause, further comprising:

a platform positioned adjacent the shell support;

a pivot assembly coupled to the shell support and the actuator, the pivot assembly positioned on a first surface of the platform; and

a securing structure positioned on a second surface of the platform, the securing structure for substantially preventing movement of the shell support during the rotating of the upper portion of the turbine shell.

8. The apparatus of any preceding clause, wherein the securing structure is coupled to a support for supporting the shell support during the rotation the upper portion of the turbine shell.

9. The apparatus of any preceding clause, wherein the actuator is operably connected to a control system configured to control the actuator during the rotating of the upper portion of the turbine shell.

10. The apparatus of any preceding clause, wherein the actuator rotates the upper portion of the turbine shell to engage a support structure positioned adjacent the turbine shell.

11. A system comprising:

a shell rotating apparatus coupled to opposing sides of an upper portion of a turbine shell, the shell rotating apparatus including:

a shell support having a first member and a second member coupled to the upper portion of the turbine shell; and

an actuator coupled to the shell support, the actuator for rotating the upper portion of the turbine shell to expose internal components of a turbine system; and

a control system operably connected to the actuator of the shell rotating apparatus, the control system configured to control the actuator during the rotating of the upper portion of the turbine shell.

12. The system of any preceding clause, further comprising a support structure positioned adjacent the shell rotating apparatus, the support structure for supporting the upper portion of the turbine shell after the rotating of the upper portion of the turbine shell by the actuator of the shell rotating apparatus.

13. The system of any preceding clause, wherein the actuator of the shell rotating apparatus rotates the upper portion of the turbine shell to a range of approximately 80 degrees and approximately 95 degrees from horizontal.

14. The system of any preceding clause, wherein the actuator is selected from the group consisting of a mechanical ball screw actuator, a hydraulic actuator, a pneumatic actuator, and an electric actuator.

15. The system of any preceding clause, wherein the first member is coupled to a plurality of apertures on a vertical flange of the upper portion of the turbine shell, the plurality of apertures on the vertical flange for coupling the upper portion of the turbine shell to

a compressor casing during operation of the turbine system.

16. The system of any preceding clause, wherein the second member is coupled to a plurality of openings on a horizontal flange of the upper portion of the turbine shell, the plurality of openings on the horizontal flange for coupling the upper portion of the turbine shell to a lower portion of the turbine shell during operation of the turbine shell.

17. The system of any preceding clause, wherein the first member and the second member are coupled to the upper portion of the turbine shell after the upper portion of the turbine shell is positioned above and separated from the lower portion of the turbine shell.

18. The system of any preceding clause, wherein the shell rotating apparatus further includes:

a platform positioned adjacent the shell support;

a pivot assembly coupled to the shell support and the actuator, the pivot assembly positioned on a first surface of the platform; and

a securing structure positioned on a second surface of the platform, the securing structure for substantially preventing movement of the shell support during the rotating of the upper portion of the turbine shell.

19. The system of any preceding clause, wherein the securing structure is coupled to a support for supporting the shell rotating apparatus during the rotation the upper portion of the turbine shell.

Claims

1. An apparatus (200) comprising:

a shell support (204) having a first member (230) and a second member (232) coupled to an upper portion (100) of a turbine shell (26); and
an actuator (248) coupled to the shell support (204), the actuator (248) for rotating the upper portion (100) of the turbine shell (26) to expose internal components of a turbine system.

2. The apparatus of claim 1, wherein the shell support (204) has a first member (230) and a second member (232) coupled to a side of the upper portion (100) of the turbine shell (26);

3. The apparatus of claim 1 or claim 2, wherein the actuator (248) rotates the upper portion (100) of the turbine shell (26) to a range of approximately 80 degrees and approximately 95 degrees from horizontal.

4. The apparatus of claim 1, 2 or 3, wherein the actuator (248) is selected from the group consisting of a mechanical ball screw actuator, a hydraulic actuator, a pneumatic actuator, and an electric actuator.

5. The apparatus of any preceding claim, wherein the first member (230) is coupled to a plurality of apertures on a vertical flange of the upper portion (100) of the turbine shell (26), the plurality of apertures on the vertical flange for coupling the upper portion (100) of the turbine shell (26) to a compressor casing during operation of the turbine system.

6. The apparatus of any preceding claim, wherein the second member (232) is coupled to a plurality of openings on a horizontal flange of the upper portion (100) of the turbine shell (26), the plurality of openings on the horizontal flange for coupling the upper portion (100) of the turbine shell (26) to a lower portion (102) of the turbine shell (26) during operation of the turbine system.

7. The apparatus of claim 6, wherein the first member (230) and the second member (232) are coupled to the upper portion (100) of the turbine shell (26) after the upper portion (100) of the turbine shell (26) is positioned above and separated from the lower portion (102) of the turbine shell (26).

8. The apparatus of claim 6 or claim 7, further comprising:

a platform (220) positioned adjacent the shell support (204);
a pivot assembly (222) coupled to the shell support (204) and the actuator (248), the pivot assembly (222) positioned on a first surface of the platform (220); and
a securing structure (206) positioned on a second surface of the platform (220) the securing structure (206) for substantially preventing movement of the shell support (204) during the rotating of the upper portion (100) of the turbine shell (26).

9. The apparatus of claim 8, wherein the securing structure (206) is coupled to a support for supporting the shell support (204) during the rotation the upper portion (100) of the turbine shell (26).

10. The apparatus of any preceding claim, wherein the actuator (248) is operably connected to a control system (260) configured to control the actuator (248) during the rotating of the upper portion (100) of the turbine shell (26).

11. The apparatus of any preceding claim, wherein the actuator (248) rotates the upper portion (100) of the turbine shell (26) to engage a support structure (258) positioned adjacent the turbine shell (26).

12. A system comprising:

a shell rotating apparatus (200) coupled to opposing sides of an upper portion (100) of a turbine shell (26), the shell rotating apparatus (200) including the apparatus of any preceding claim; and
a control system (260) operably connected to the actuator (248) of the shell rotating apparatus (200), the control system (260) configured to control the actuator (248) during the rotating of the upper portion of the turbine shell (26).

13. The system of claim 12, further comprising a support structure (258) positioned adjacent the shell rotating apparatus (200), the support structure (258) for supporting the upper portion (100) of the turbine shell (26) after the rotating of the upper portion (100) of the turbine shell (26) by the actuator (248) of the shell rotating apparatus (200).

14. The system of claim 12 or Claim 13, wherein the actuator (248) of the shell rotating apparatus (200) rotates the upper portion (100) of the turbine shell (26) to a range of approximately 80 degrees and approximately 95 degrees from horizontal.

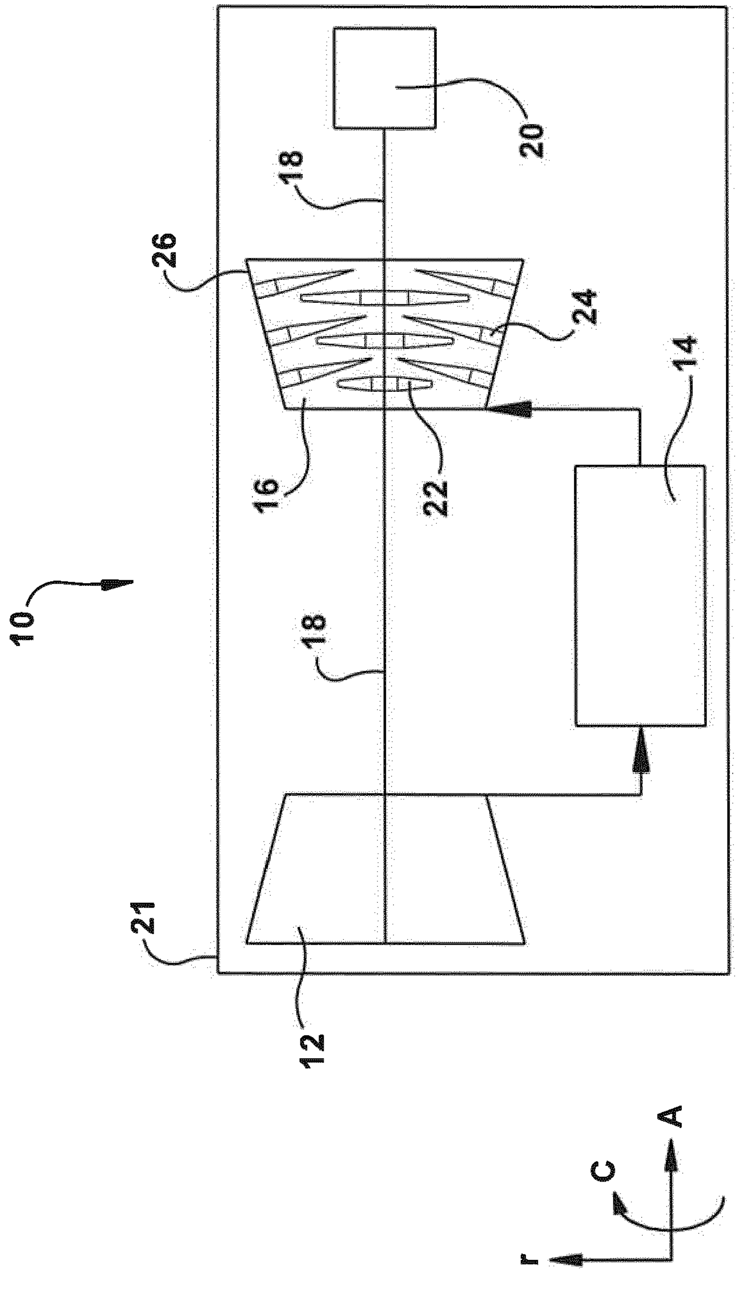

FIG. 1

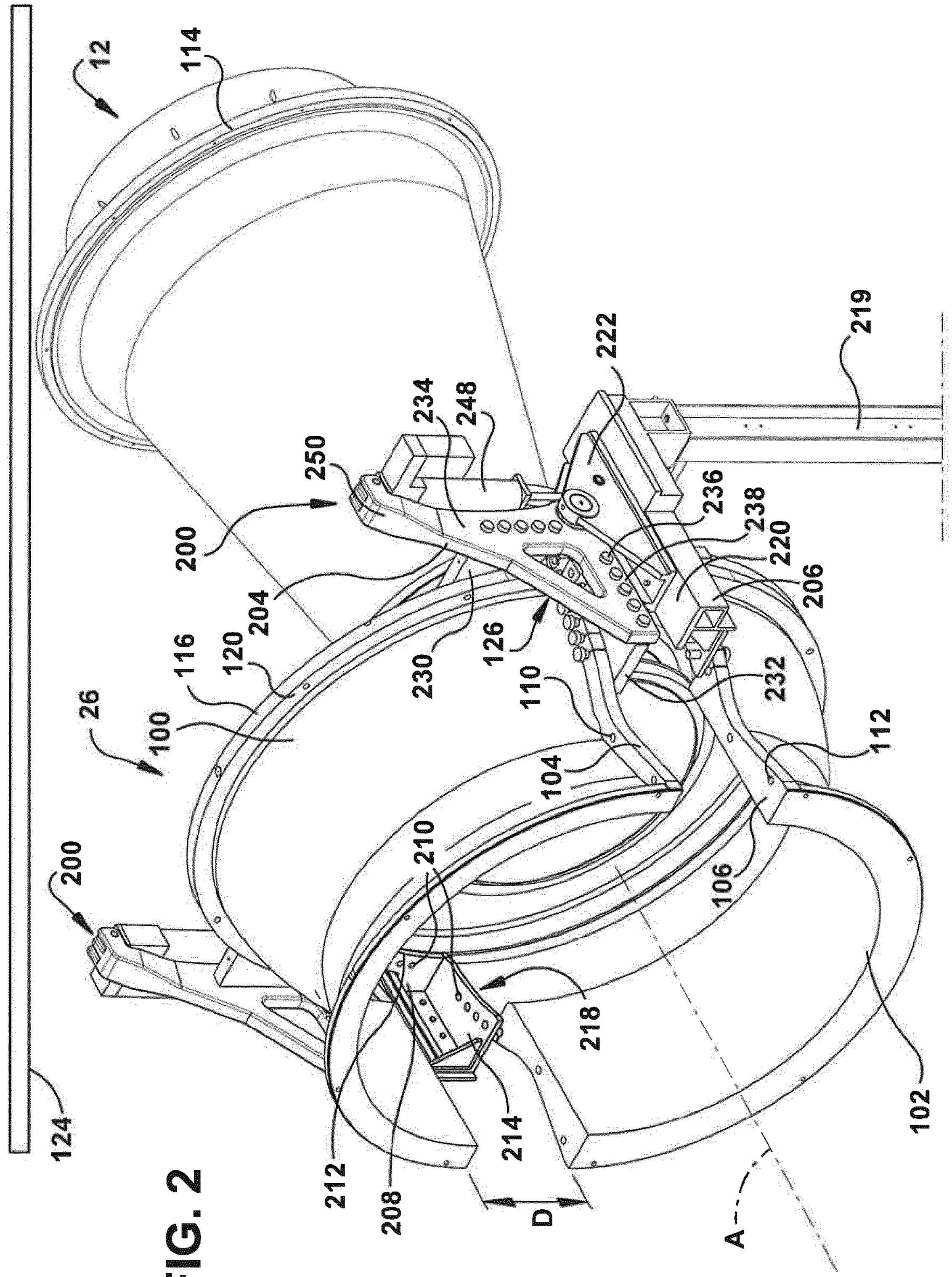
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FIG. 2

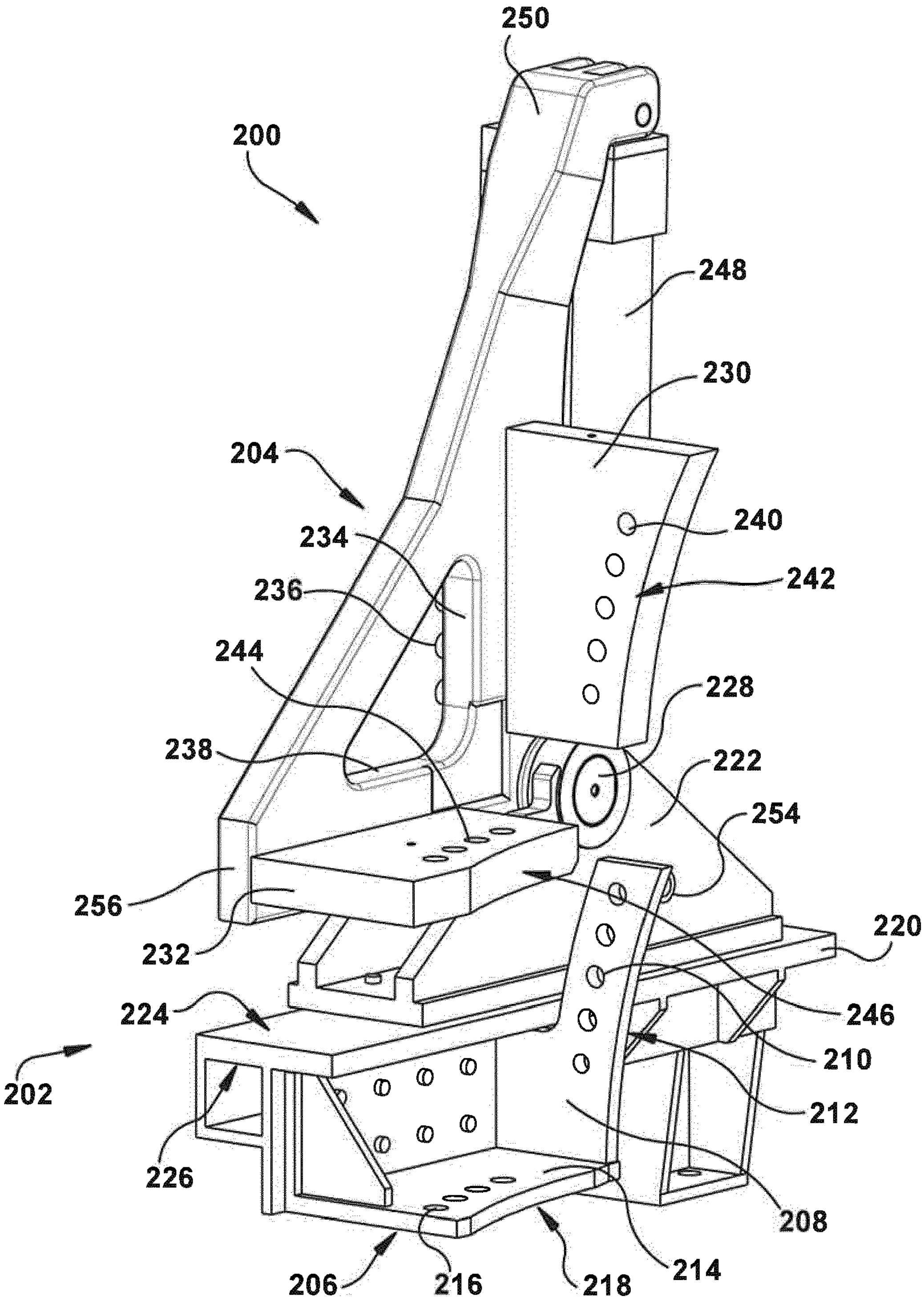
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FIG. 3

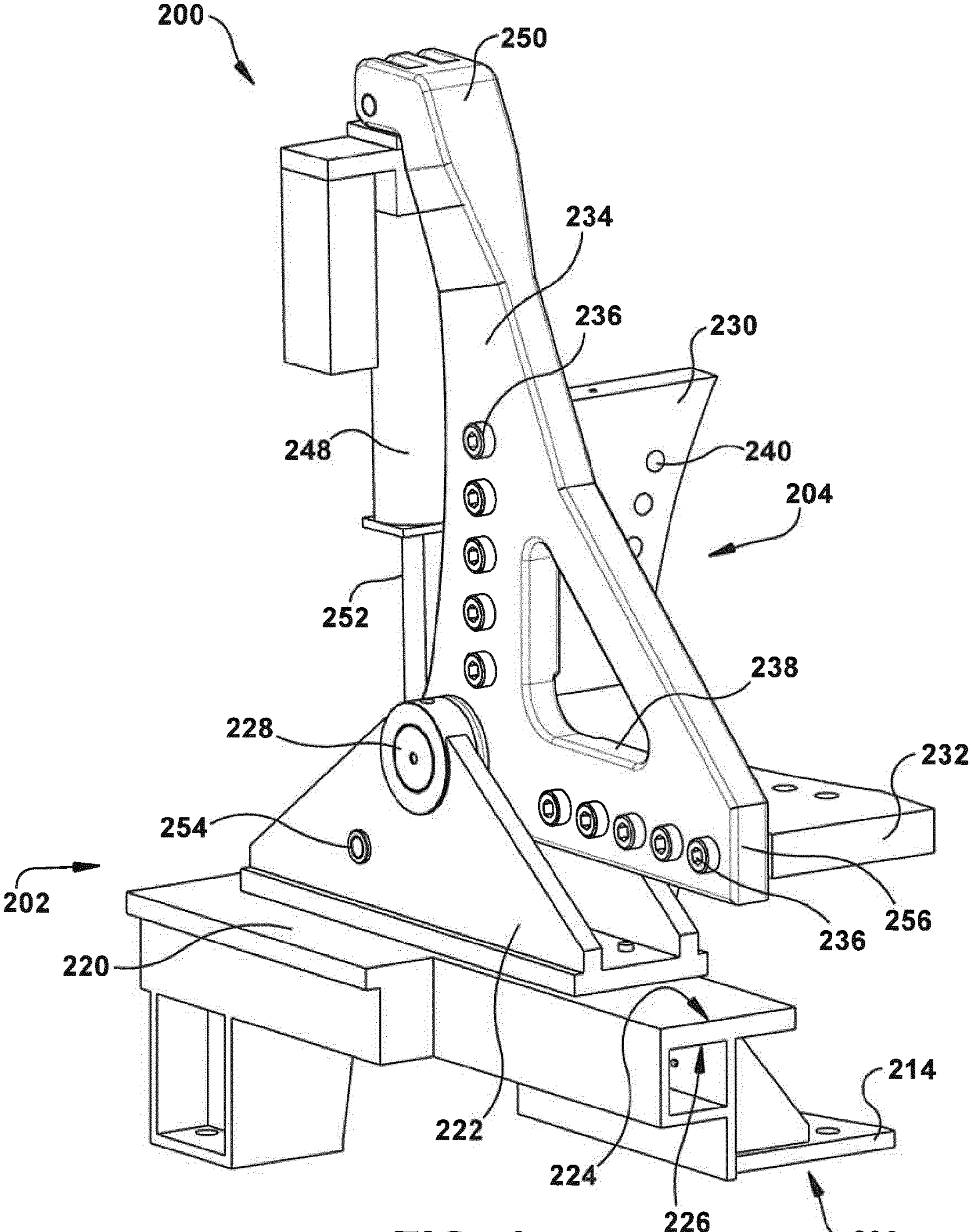
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FIG. 4

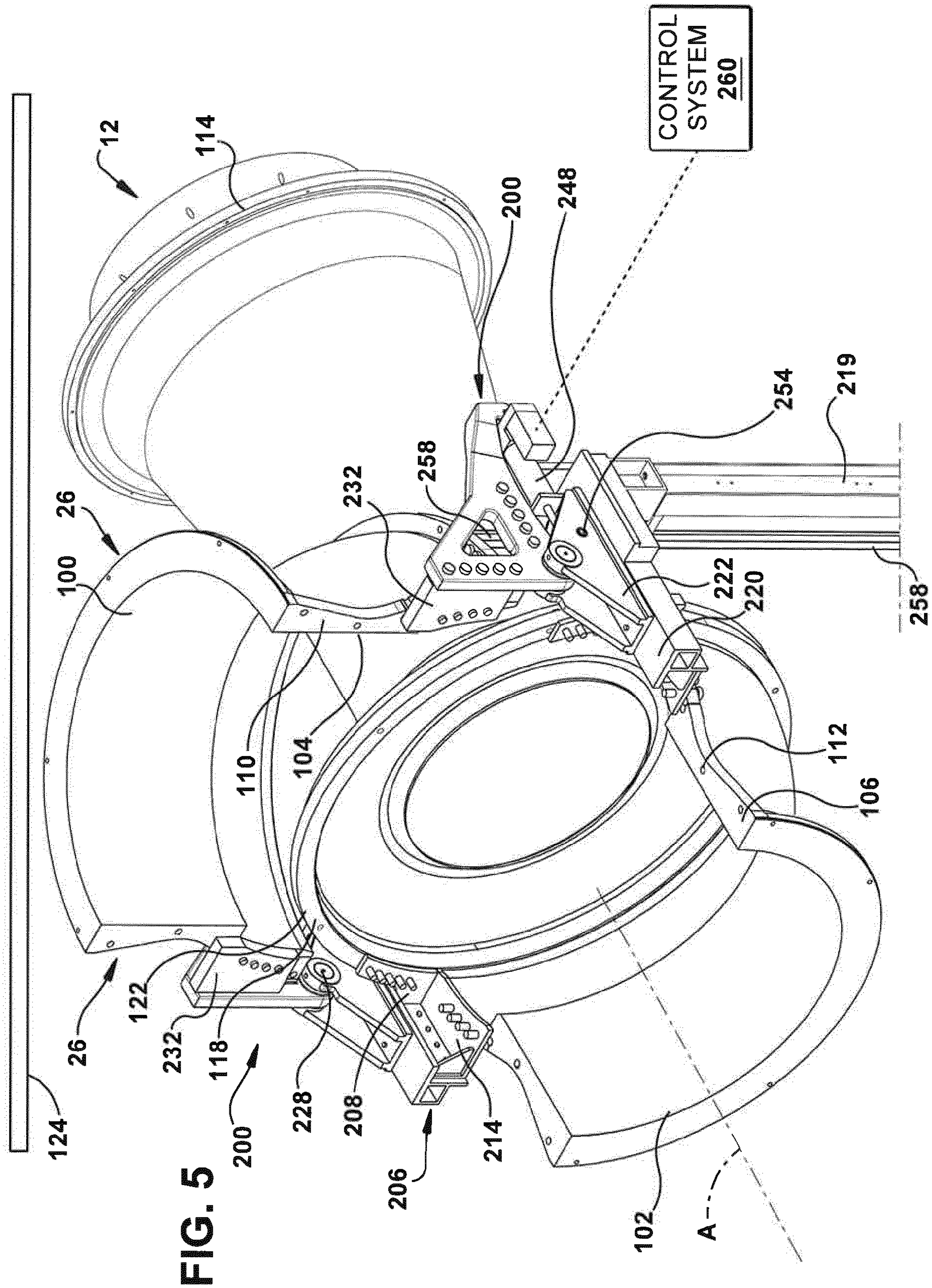
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FIG. 5

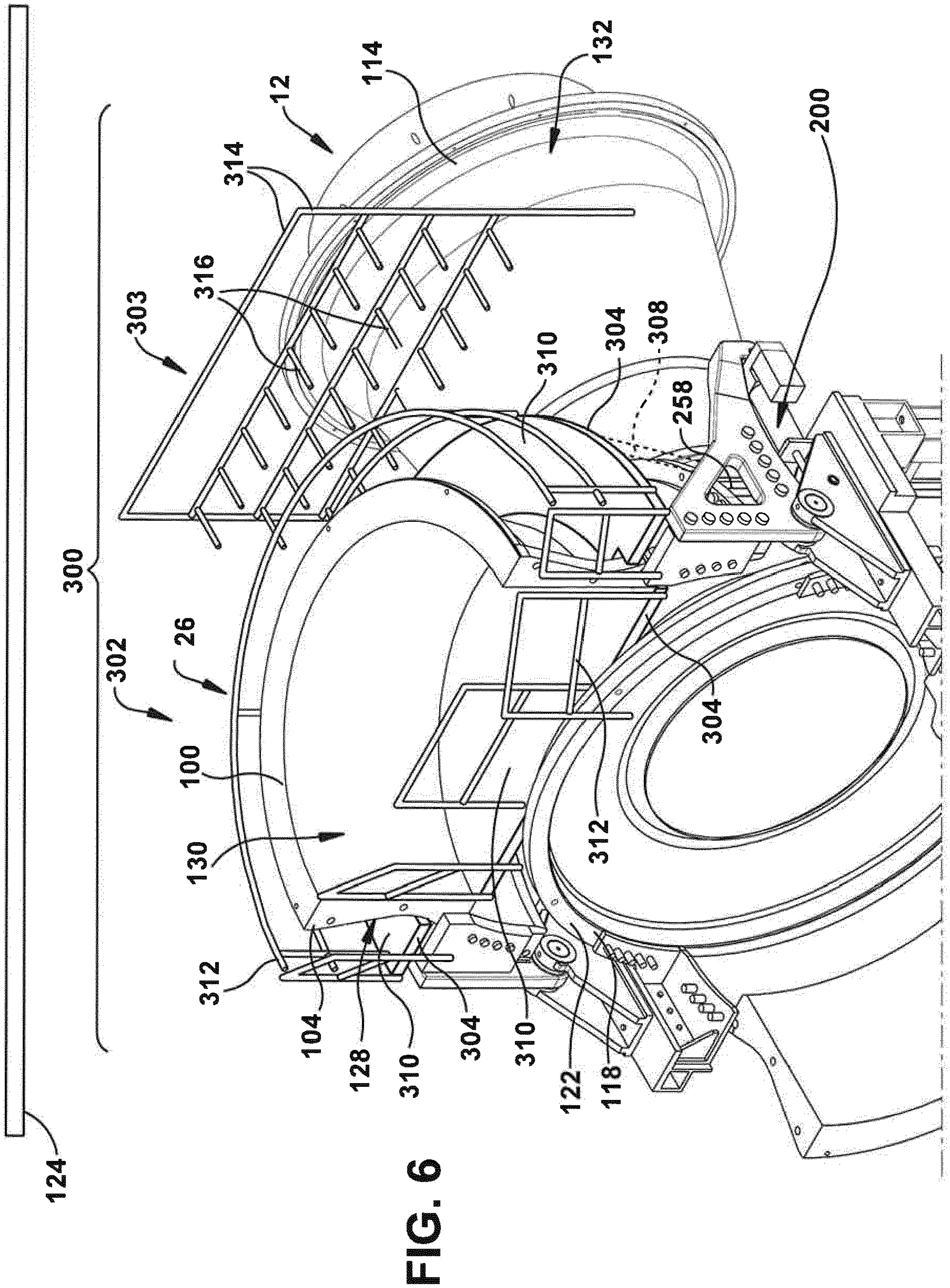
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FIG. 6

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EUROPEAN SEARCH REPORT

Application Number
EP 14 17 1154

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F02C
B66C
B65G

The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
Munich	24 September 2014	Koch, Rafael

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