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- **DZIECIOL, Piotr Krzysztof**
02-256 PL Warszawa (PL)
- **KLEJC, Adrian Adam**
02-256 PL Warszawa (PL)
- **PERKOWSKI, Szymon**
02-256 PL Warszawa (PL)

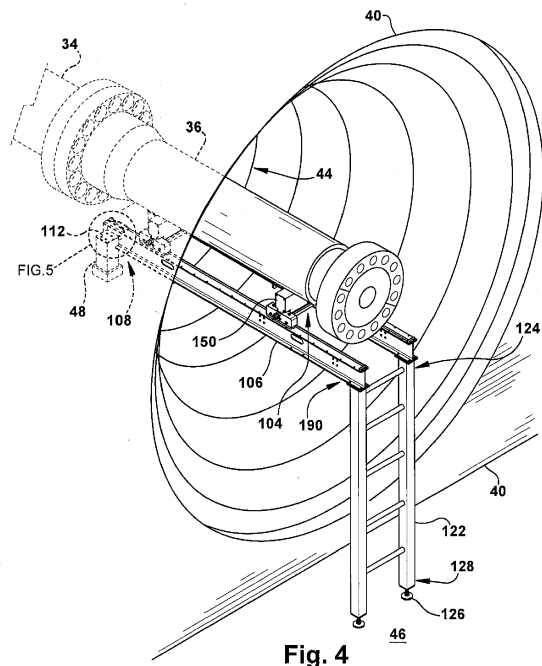
(71) Applicant: **General Electric Company**
Schenectady, NY 12345 (US)

(74) Representative: **Slominska-Dziubek, Anna**
PolSERVICE
Kancelaria Rzeczników
Patentowych sp. z o.o.
Bluszczanska 73
00-712 Warszawa (PL)

(72) Inventors:
• **GACA, Magdalena**
02-256 PL Warszawa (PL)

(54) **INSTALLATION APPARATUS FOR A LOAD-COUPLING OF A TURBINE SYSTEM AND METHOD OF INSTALLING A LOAD-COUPLING IN A TURBINE SYSTEM**

(57) Installation apparatuses for installing load-couplings in turbine systems are disclosed. The installation apparatuses may include a plurality of rails extending axially through a portion of a diffuser of the turbine system. Each of the plurality of rails may include a first distal end positioned within and releasably coupled to the diffuser, and a second distal end positioned opposite the first distal end. The installation apparatuses may also include at least one trolley positioned on the plurality of rails. The trolley(s) may include a plurality of wheel housings. Each wheel housing may include at least one wheel slidably engaging a corresponding rail of the plurality of rails. The trolley(s) of the installation apparatuses may also include a cradle component positioned within each of the plurality of wheel housings. The cradle component may receive the load-coupling of the turbine system. A corresponding method of installing a load-coupling in a turbine system using such an installation apparatus is also provided.

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Description

BACKGROUND OF THE INVENTION

[0001] The disclosure relates generally to installation apparatuses for turbine systems, and more particularly, to installation apparatuses for load-couplings of turbine systems, and methods of installing load-couplings within turbine systems using installation apparatuses.

[0002] In conventional turbine systems exhaust housings, frames or diffusers are typically attached or coupled to an outlet of a turbine component. These diffusers are attached to the turbine component to safely direct gases passing through and/or from the turbine component into the environment surrounding the turbine system, or alternatively, to direct the gases to another component that may utilize the gases for additional processes (e.g., a heat recovery steam generator). In some examples, the diffusers are positioned directly adjacent to, and downstream from generators of the turbine system. The clearance between the diffusers and generators of the turbine system may be minimal (e.g., 2-3 meters) to improve efficiency of the turbine system and/or to reduce the risk of undesirable exposure and/or undesirable operation of a load-coupling section of the rotor that may couple a turbine section of the rotor with the generator section of the rotor.

[0003] Because of the minimal clearance between the diffuser and the generator, it is difficult and/or time consuming to replace the load-coupling of the turbine system. For example, one conventional process of replacing the load-coupling includes removing/disassembling the diffuser and/or generator of the turbine system to provide access to the load-coupling. This conventional process is labor intensive, requires the removal/disassembling of large components (e.g., diffuser formed as single, unitary component) and/or a large number of components, and requires the turbine system to be non-operational for an extend period of time.

[0004] In another non-limiting example, a crane is used to both remove, support, and install the load-couplings with the turbine system. In this non-limiting example, the crane is positioned above the diffuser and generator and the load-coupling is rotated to be substantially vertical and then lowered into the space or clearance between the diffuser and the generator. The load-coupling may then be rotated to be substantially horizontal and simultaneously positioned or inserted into the diffuser on the side adjacent the generator to be coupled to the turbine section of the rotor with the generator section of the rotor, respectively. However, this conventional process is also time consuming, and increases the risk of the load-coupling, the diffuser, and/or the generator from being damaged if the load-coupling is not perfectly passed or threaded through the minimal clearance between the diffuser and the generator. Additionally, because of the minimal or small clearance between the diffuser and the generator, this conventional process for installing the load-

coupling may only work when the load-coupling includes a length that is smaller than a predetermined length. That is, in some instances the load-coupling for the turbine system may be too long to install using the crane because there may not be enough space or clearance between the diffuser and the generator to allow the load-coupling to rotate to be substantially horizontal before being coupled to the turbine section and generator section of the rotor.

BRIEF DESCRIPTION OF THE INVENTION

[0005] A first aspect of the disclosure provides an installation apparatus for a load-coupling of a turbine system. The installation apparatus includes: a plurality of rails extending axially through a portion of a diffuser of the turbine system, each of the plurality of rails including: a first distal end positioned within and releasably coupled to the diffuser; and a second distal end positioned opposite the first distal end; and at least one trolley positioned on the plurality of rails, the at least one trolley including: a plurality of wheel housings, each wheel housing including at least one wheel slidably engaging a corresponding rail of the plurality of rails; and a cradle component positioned partially within each of the plurality of wheel housings, the cradle component for receiving the load-coupling of the turbine system.

[0006] A second aspect of the disclosure provides a method of installing a load-coupling in a turbine system using an installation apparatus. The method includes: positioning the installation apparatus at least partially within a diffuser of the turbine system, the installation apparatus including: a plurality of rails releasably coupled to and extending axially through a portion of the diffuser, toward a generator of the turbine system; and at least one trolley positioned on the plurality of rails, the at least one trolley including: a plurality of wheel housings, each wheel housing including at least one wheel slidably engaging a corresponding rail of the plurality of rails; and a cradle component positioned partially within each of the plurality of wheel housings; positioning the load-coupling of the turbine system on the cradle component of the at least one trolley of the installation apparatus by moving the load-coupling through the diffuser adjacent a turbine of the turbine system using the at least one trolley of the installation apparatus; and coupling the load-coupling of the turbine system to at least one of: a turbine section of a rotor of the turbine system, or a generator section of the rotor of the turbine system.

[0007] The illustrative aspects of the present disclosure are designed to solve the problems herein described and/or other problems not discussed.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] These and other features of this disclosure will be more readily understood from the following detailed description of the various aspects of the disclosure taken

in conjunction with the accompanying drawings that depict various embodiments of the disclosure, in which:

FIG. 1 shows a schematic diagram of a turbine system, according to embodiments of the disclosure.

FIG. 2A shows an exploded, perspective view of an installation apparatus including a platform portion and trolleys, according to embodiments of the disclosure.

FIG. 2B shows an enlarged view of an adjustable component of the platform portion of the installation apparatus of FIG. 2A, according to embodiments of the disclosure.

FIG. 3 shows an exploded, perspective view of a trolley of the installation apparatus of FIG. 2A, according to embodiments of the disclosure.

FIG. 4 shows a perspective view of the installation apparatus of FIG. 2A positioned within a diffuser of a gas turbine system, according to embodiments of the disclosure.

FIG. 5 shows a magnified, perspective view of a portion of the installation apparatus and diffuser of FIG. 4, according to embodiments of the disclosure.

FIG. 6 shows a perspective view of an installation apparatus including a platform portion and a trolley, according to additional embodiments of the disclosure.

FIG. 7 shows an exploded, perspective view of the trolley of the installation apparatus of FIG. 6, according to embodiments of the disclosure.

FIG. 8 shows an assembled, perspective view of the trolley shown in FIG. 7, according to embodiments of the disclosure.

FIG. 9 shows an exploded, perspective view of a trolley of an installation apparatus, according to further embodiments of the disclosure.

FIG. 10 shows a flow chart of an example process for installing a load-coupling in a turbine system using an installation apparatus, according to embodiments of the disclosure.

FIGs. 11-14 show a side view of a portion of a turbine component, a diffuser, and a load-coupling of a turbine system undergoing an installation process using an installation apparatus, according to embodiments of the disclosure.

[0009] It is noted that the drawings of the disclosure are not to scale. The drawings are intended to depict only typical aspects of the disclosure, and therefore should not be considered as limiting the scope of the disclosure. In the drawings, like numbering represents like elements between the drawings.

DETAILED DESCRIPTION OF THE INVENTION

[0010] As an initial matter, in order to clearly describe the current disclosure it will become necessary to select certain terminology when referring to and describing rel-

evant machine components within the disclosure. When doing this, if possible, common industry terminology will be used and employed in a manner consistent with its accepted meaning. Unless otherwise stated, such terminology should be given a broad interpretation consistent with the context of the present application and the scope of the appended claims. Those of ordinary skill in the art will appreciate that often a particular component may be referred to using several different or overlapping terms. What may be described herein as being a single part may include and be referenced in another context as consisting of multiple components. Alternatively, what may be described herein as including multiple components may be referred to elsewhere as a single part.

[0011] In addition, several descriptive terms may be used regularly herein, and it should prove helpful to define these terms at the onset of this section. These terms and their definitions, unless stated otherwise, are as follows. As used herein, "downstream" and "upstream" are terms that indicate a direction relative to the flow of a fluid, such as the working fluid through the turbine engine or, for example, the flow of air through the combustor or coolant through one of the turbine's component systems. The term "downstream" corresponds to the direction of flow of the fluid, and the term "upstream" refers to the direction opposite to the flow. The terms "forward" and "aft," without any further specificity, refer to directions, with "forward" referring to the front or compressor end of the engine, and "aft" referring to the rearward or turbine end of the engine. Additionally, the terms "leading" and "trailing" may be used and/or understood as being similar in description as the terms "forward" and "aft," respectively. It is often required to describe parts that are at differing radial, axial and/or circumferential positions. The "A" axis represents an axial orientation. 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 the turbine system (in particular, the rotor). As further used herein, the terms "radial" and/or "radially" refer to the relative position/direction of objects along an axis "R" (see, FIG. 1), which is substantially perpendicular with axis A and intersects axis A at only one location. Finally, the term "circumferential" refers to movement or position around axis A (e.g., axis "C").

[0012] The following disclosure relates generally to installation apparatuses for turbine systems, and more particularly, to installation apparatuses for load-couplings of turbine systems, and methods of installing load-couplings within turbine systems using installation apparatuses.

[0013] These and other embodiments are discussed below with reference to FIGs. 1-14. However, those skilled in the art will readily appreciate that the detailed description given herein with respect to these Figures is for explanatory purposes only and should not be construed as limiting.

[0014] FIG. 1 shows a schematic view of gas turbine

system 10 as may be used herein. Gas turbine system 10 may include a compressor 12. Compressor 12 compresses an incoming flow of air 18. Compressor 12 delivers a flow of compressed air 20 to a combustor 22. Combustor 22 mixes the flow of compressed air 20 with a pressurized flow of fuel 24 and ignites the mixture to create a flow of combustion gases 26. Although only a single combustor 22 is shown, gas turbine system 10 may include any number of combustors 22. The flow of combustion gases 26 is in turn delivered to a turbine 28, which typically includes a plurality of turbine blades or buckets and stator vanes. The flow of combustion gases 26 drives turbine 28 to produce mechanical work. The mechanical work produced in turbine 28 drives compressor 12 via a rotor 30 extending through turbine 28, and may be used to drive an external load, such as an electrical generator 32 (hereafter, "generator 32" and/or the like). Rotor 30 may be segmented and/or may include distinct, coupled portions to form a unitary shaft for gas turbine system 10. For example, rotor 30 may include a turbine portion 34 included within turbine 28, and a load-coupling 36 coupling turbine portion 34 of rotor 30 and a generator portion 38 of rotor 30 included within generator 32 of gas turbine system 10. As a result of coupling turbine portion 34 and generator portion 38, load-coupling 36 may also translate the rotate of turbine portion 34 to generator portion 38 drive generator 32 and/or drive the external load.

[0015] Gas turbine system 10 may also include a diffuser 40. As shown in FIG. 1, diffuser 40 may be positioned adjacent turbine 28 of gas turbine system 10. More specifically, diffuser 40 may be positioned adjacent to turbine 28 and may be positioned substantially downstream of turbine 28 and/or the flow of combustion gases 26 flowing from combustor 22 to turbine 28. As discussed herein, a portion (e.g., outer casing) of diffuser 40 may be coupled directly to an enclosure, shell or casing 42 (hereafter, "casing 42") of turbine 28. In the non-limiting example shown in FIG. 1, load-coupling 36 may be at least partially positioned within and/or extend axially through diffuser 40.

[0016] Subsequent to combustion gases 26 flowing through and driving turbine 28, combustion gases 26 may be exhausted, flow-through and/or discharged through diffuser 40 in a flow direction (D). In the non-limiting example shown in FIG. 1, combustion gases 26 may flow through diffuser 40 in the flow direction (D) and may be discharged from gas turbine system 10 (e.g., to the atmosphere). In another non-limiting example where gas turbine system 10 is part of a combined cycle power plant (e.g., including gas turbine system and a steam turbine system), combustion gases 26 may discharge from diffuser 40, and may flow in the flow direction (D) into a heat recovery steam generator of the combined cycle power plant.

[0017] FIG. 2A shows an exploded, perspective view of a non-limiting example of an installation apparatus 100. Installation apparatus 100 may be utilized by a tur-

bine system (e.g., gas turbine system 10) for installing portions of a rotor. For example, and with continued reference to FIG. 1, installation apparatus 100 may be utilized to install of load-coupling 36 within gas turbine system 10. As discussed herein, installation apparatus 100 may aid in the installation of portions of a rotor, such as load-coupling 36, within gas turbine system 10 where there is minimal space and/or clearance (e.g., approximately 2 meters to approximately 3 meters) between diffuser 40 and generator 32.

[0018] As shown in FIG. 2A, installation apparatus 100 may include a platform portion 102 and at least one trolley 104 positioned on platform portion 102. Platform portion 102 may include a plurality of rails 106. In the non-limiting example shown in FIG. 2A, each rail 106 may be a solid, single body component. In other non-limiting examples discussed herein (see, FIG. 6), each rail 106 may be formed from distinct portions that may be joined and/or coupled prior to utilizing installation apparatus 100. The plurality of rails 106 may be formed from any suitable material that may be substantially rigid and capable of withstanding the weight of load-coupling 36 of gas turbine system 10 during the installation process discussed herein. For example, each of the plurality of rails of installation apparatus 100 may be formed from material including, but not limited to, metal, metal alloys, polymers, or wood. As discussed herein (see, FIGs. 4 and 5), the plurality of rails 106 of installation apparatus 100 may be directly coupled to diffuser 40 and may extend axially through a portion of diffuser 40 when being utilized within gas turbine system 10 to aid in the installation of load-coupling 36.

[0019] Each of the plurality of rails 106 may include two distal ends 108, 110. Specifically, each rail 106 of installation apparatus 100 may include a first distal end 108, and a second distal end 110 formed opposite first distal end 108. As discussed herein (see, FIGs. 4 and 5), first distal end 108 may be positioned within, surrounded by, and/or coupled directly to diffuser 40 of gas turbine system 10 when installation apparatus 100 is utilized to install load-coupling 36 within gas turbine system 10. To aid in coupling each rail 106 of installation apparatus 100 to diffuser 40, first distal end 108 of rail 106 may include a coupling plate 112. That is, each rail 106 may include coupling plate 112 formed at first distal end 108 to directly couple each rail 106 to diffuser 40. In a non-limiting example, coupling plate 112 may be formed as a distinct component from rail 106, and may be coupled or affixed to first distal end 108 of rail 106 using any suitable joining or coupling technique. For example, coupling plate 112 may be releasably fastened (e.g., bolted, screwed), or alternatively, may be welded or brazed directly to first distal end 108 of rail 106. In another non-limiting example (not shown), coupling plate 112 may be formed integral with rail 106 and/or first distal end 108 of rail 106. Similar to rail 106, coupling plate 112 may be formed from any suitable material that may be substantially rigid, maintain a coupling with diffuser 40 of gas turbine system 10, and

capable of withstanding the weight of load-coupling 36 experienced by rail 106 during the installation process discussed herein. For example, each of the plurality of rails of installation apparatus 100 may be formed from material including, but not limited to, metal, metal alloys, polymers, or ceramics. In the non-limiting examples, coupling plate 112 may be formed from a material that is the same or distinct from the material forming rails 106.

[0020] In the non-limiting examples where coupling plate 112 is coupled or affixed to first distal end 108 of each rail 106, each rail 106 of installation apparatus 100 may utilize a plurality of interchangeable coupling plates 112 to couple rail 106 of installation apparatus 100 to distinct diffusers in distinct turbine systems. That is, various, distinct coupling plates 112 may be interchangeably coupled or affixed to first distal end 108 of rail 106 to allow installation apparatus 100 to be easily coupled to distinct diffusers and/or utilized by various distinct, turbine systems for installing load-couplings. As discussed herein (see, FIG. 6), each of the plurality of coupling plates 112 may include a geometry corresponding to a distinct diffuser of a distinct turbine system.

[0021] As shown in FIG. 2A, each rail 106 may also include a track 118. Specifically, track 118 may be positioned on a top surface 120 of each rail 106 of platform portion 102. Track 118 may be releasably coupled to, affixed to, or formed integral with top surface 120 of each rail 106. In the non-limiting examples where track 118 is releasably coupled or affixed to top surface 120, rails 106 may be configured to receive a plurality of distinct tracks 118 including different lengths and/or structures or configurations. The different lengths may depend on a variety of characteristics of installation apparatus 100 and/or gas turbine system 10 including, but not limited to, the configuration of trolley(s) 104, the size of trolley(s) 104, the length of rails 106, the length/size of load-coupling 36, the distance between diffuser 40 and generator 32, and so on. Additionally track 118 may extend over at least a portion of the length of rail 106. In the non-limiting example shown, track 118 may extend between first distal end 108 and second distal end 110, respectively, of rail 106. As discussed herein, track 118 positioned on top surface 120 of each rail 106 may receive, contact, and guide the axial movement of trolley(s) 104 during the installation process of load-coupling 36. Track 118 may be formed from any suitable rigid material including, but not limited to, metal, metal alloys, polymer, ceramic and the like.

[0022] Platform portion 102 of installation apparatus 100 may also include a plurality of supports 122. The plurality of supports 122 of installation apparatus 100 may extend radially below the plurality of rails 106. More specifically, and as shown in FIG. 2A, the plurality of supports may be positioned substantially perpendicular to, extend radially from, and/or substantially below the plurality of rails 106 of platform portion 102 of installation apparatus 100. Each of the plurality of supports 122 may be releasably coupled to a corresponding rail 106 of the plurality of rails. That is, a single support 122 may be

releasably coupled to and may substantially support and/or stabilize a single, corresponding rail 106 of installation apparatus 100 during the installation process discussed herein. In the non-limiting example, a first end 124 of each support 122 may be releasably coupled to second distal end 110 of corresponding rail 106 using any suitable coupling technique including, but not limited to, fasteners, latches, clamps, ties, pins, and the like. In the non-limiting example shown in FIG. 2A, and similar to the plurality of rails 106 discussed herein, each support 122 may be a solid, single body component. In other non-limiting examples discussed herein (see, FIG. 6), each support 122 may be formed from distinct portions that may be joined and/or coupled prior to utilizing installation apparatus 100. The plurality of supports 122 may be formed from any suitable material that may be substantially rigid and capable of withstanding the weight of load-coupling 36 imparted on the plurality of rails 106 during the installation process discussed herein. For example, each of the plurality of supports 122 of installation apparatus 100 may be formed from material including, but not limited to, metal, metal alloys, polymers, or wood.

[0023] Each support 122 of platform portion 102 may also include an adjustable component 126. As shown in FIG. 2A, adjustable component 126 may be formed at a second end 128 of each support 122. That is, adjustable components 126 may be formed and/or coupled to second end 128 of support 122, opposite first end 124 and/or second distal end 110 of rails 106. Adjustable component 126 formed on each support 122 to substantially adjust the height of support 122 and/or level support 122. In conjunction with adjusting the height and/or leveling support 122, and as discussed herein, adjustable component 126 may also substantially adjust the height, incline, and/or level the respective rails 106 of installation apparatus 100 that may be coupled to supports 122. In a non-limiting example shown in FIG. 2B, each adjustable component 126 may include a threaded screw 130 coupled directly to second end 128 of support 122, and a stabilizer foot 132 (hereafter, "foot 132"), coupled directly to threaded screw 130. In order to adjust the height and/or level support 122 of installation apparatus 100, the threaded screw 130 may be turned within second end 128 of support 122 to either increase or decrease the length of threaded screw 130 until foot 132 of adjustable component 126 contacts and/or is secured to a surface positioned below support 122. Although threaded screw 130 and foot 132 are shown, it is understood that adjustable component 126 may be any suitable component or assembly that may adjust the height of support 122 and/or level support 122. For example, adjustable component 126 may include a hydraulic/pneumatic/mechanical jack, hydraulic/pneumatic/mechanical lifts, wedges and the like.

[0024] Installation apparatus 100 may also include at least one trolley 104. In the non-limiting example shown in FIG. 2A, installation apparatus 100 is shown to include two trolleys 104. However, it is understood that the

number of trolleys 104 included within installation apparatus 100 is merely illustrative. As such, installation apparatus 100 may include more or less (see, FIG. 6) trolleys 104 than the number of trolleys 104 depicted in FIG. 2A. The number of trolleys 104 included within installation apparatus may be dependent, at least in part on, the configuration of trolley(s) 104, the size of trolley(s) 104, the length of rails 106, the length/size/weight of load-coupling 36, and so on. As discussed herein, trolley(s) 104 may be positioned on, may contact, and/or may slidably engage rails 102 when utilizing installation apparatus 100 to install load-coupling 36 within turbine system 10 (see, FIG. 1).

[0025] Turning to FIG. 3, and with continued reference to FIG. 2A, an exploded, perspective view of trolley(s) 104 of installation apparatus 100 is shown. Trolley(s) 104 may include a plurality of wheel housing 134. Each wheel housing 134 of trolley(s) 104 may include at least one wheel 136. The number of wheel(s) 136 included within wheel housing 134 of trolley(s) 104 may be dependent on, for example, the configuration of wheel housing 134, the size of wheel housing 134, the length of rails 106, the length/size/weight of load-coupling 36, and the like. During the installation process, the wheel(s) 136 of wheel housings 134 may slidably engage a corresponding rail 106 of installation apparatus 100. That is, each wheel 136 of wheel housing 134 may substantially contact, move/roll over, and/or slidably engage a corresponding rail 106 of installation apparatus 100 as trolley(s) 104, and more specifically wheel housing 134, moves in an axial direction on a corresponding rail 106 during the installation process discussed herein. Although discussed and shown herein as wheel(s) 136, it is understood that wheel housing 134 may include any assembly and/or component that may allow wheel housing 134 and/or trolley(s) 104 of installation apparatus to move in an axial direction on rails 106.

[0026] Additionally, each wheel housing 134 and/or wheel(s) 136 of wheel housing 134 may contact a respective track 118 formed on rail 106 (see, FIG. 2A) when performing the installation process discussed herein. That is, track 118 formed on each rail 106 of platform portion 102 may substantially receive, contact, brace, and/or guide each wheel housing 134 and/or wheel(s) 136 of wheel housing 134 when wheel(s) 136 slidably engage and move in an axial direction over rails 106. In the non-limiting example shown in FIG. 2A, tracks 118 formed on rails 106 may be positioned between wheel housings 134 of trolley 104 to substantially prevent trolley 104 from undesirably shifting in a radial direction and/or from being removed or falling off of rails 106 during the installation process.

[0027] Wheel housings 134 of trolley 104 may also include a recess 138 formed therein. As shown in FIG. 3, each wheel housing 134 of trolley 104 may include recess 138 formed on an inner surface 140, such that the respective recesses 138 of wheel housings 134 may face one another, be positioned opposite one another,

and/or may be radially aligned. Recesses 138 of each wheel housing 134 of trolley 104 may receive a portion of a cross member 142. Specifically, cross member 142 may include projections 144 that may be positioned within and/or received by a corresponding recess 138 of wheel housing 134 to substantially fix or couple cross member 142 to each of wheel housing 134 of trolley 104. In the non-limiting example shown in FIG. 3, cross member 142 may be fixed to wheel housing 134 of trolley 104 using a plurality of fasteners 146 (e.g., screws) that may pass through apertures 148 formed through wheel housing 134 and/or recess 138, and fasteners 146 may be coupled to projection 144 of cross member 142 positioned within a corresponding recess 138. Fixing cross member 142 to each of the plurality of wheel housings 134 of trolley 104 may substantially ensure that each wheel housing 134 moves in an axial direction together or in sync during the installation process discussed herein.

[0028] As shown in FIGs. 2A and 3, trolley 104 may also include a cradle component 150. Cradle component 150 may be positioned within each of the plurality of wheel housings 134 of trolley 104. Specifically, a portion of cradle component 150 may be positioned within each recess 138 of wheel housings 134 of trolley 104, and cradle component 150 may be positioned and/or extend between each wheel housing 134. Additionally as shown in FIG. 3, cradle component 150 may be positioned above and/or positioned on cross member 142. That is, cross member 142 may be positioned below and may substantially support cradle component 150 of trolley 104. Cradle component 150 may substantially contact, receive, cradle, and/or support load-coupling 36 of turbine system 10 during an installation process discussed herein (see, FIG. 4). Cradle component 150 may substantially contact, receive, cradle, and/or support load-coupling 36 on contact surface 152. Contact surface 152 of cradle component 150 that may contact, receive, cradle, and/or support load-coupling 36 may include a curved geometry 154 that may substantially correspond to a curvature of load-coupling 36 of turbine system 10 (see, FIG. 1). That is, curved geometry 154 of contact surface 152 may correspond, be similar/equal to, and/or may be substantially concentric with the curvature of load-coupling 36 to ensure that load-coupling 36 is not able to undesirably shift (e.g., in a radial direction) when positioned within cradle component 150 during the installation process.

[0029] Cradle component 150 of trolley 104 may be formed from any suitable material that may be substantially rigid and capable of withstanding the weight of load-coupling 36 of gas turbine system 10 during the installation process discussed herein. For example, cradle component 150 of trolley 104 of installation apparatus 100 may be formed from material including, but not limited to, metal, metal alloys, polymers, ceramics, wood, or the like. Additionally, and as shown in the non-limiting example of FIGs. 2A and 3, cradle component 150 may be formed as a single, unitary component. In other non-lim-

iting examples discussed herein (see, FIGs. 6-9), cradle component 150 may be formed from distinct portions that may be assembled in place (e.g., within diffuser 40) and may be coupled together before receiving load-coupling 36 during the installation process.

[0030] As discussed herein, curved geometry 154 of contact surface 152 of cradle component 150 may correspond to a curvature of load-coupling 36. In a non-limiting example, a plurality of cradle components 150 may be created and/or manufactured to receive distinct load-couplings 36 for various turbine systems 10 (e.g., see, FIG. 1). Each of the plurality of cradle components 150 may include contact surface 152 having a distinct or unique curved geometry 154 that may corresponding to a curvature of a distinct load-coupling 36. In this non-limiting example, each of the plurality of cradle components 150 including distinct or unique curved geometries 154 may be interchangeably received, positioned within and/or coupled to each of the plurality of wheel housings 134 of trolley(s) 104. That is, the plurality of wheel housings 134 of a single trolley 104 for installation apparatus 100 may be configured to receive a plurality of cradle components 150, each including distinct or unique curved geometries 154 for contact surfaces 152.

[0031] Trolley(s) 104 of installation apparatus 100 may also include a plurality of displacement components configured to adjust the position of cradle component 150 within trolley 104. For example, at least one wheel housing 134 of trolley 104 may include a displacement component 156. As shown in FIG. 3, each wheel housing 134 of trolley 104 may include displacement component 156 positioned within an aperture 158 formed through recess 138 of wheel housing 134, and displacement component 156 may extend partially into recess 138. Displacement component 156 may also be positioned adjacent to and may substantially contact a side surface 160 of cradle component 150. Displacement components 156 may contact side surface 160 of cradle component 150 to adjust the position of cradle component 150 between the plurality of wheel housings 134 of trolley 104. That is, displacement components 156 may contact side surface 160 of cradle component 150 to adjust and/or shift the radial position of cradle component 150 between the plurality of wheel housings 134, and/or to move cradle component 150 over cross member 142.

[0032] In the non-limiting example shown in FIG. 3, displacement components 156 may be configured as threaded bolts that may be turned within aperture 158 formed through wheel housing 134 to either increase or decrease the length of the portion of displacement component 156 extending into recess 138 and contacting cradle component 150. Increasing and/or decreasing the length of the portion of displacement component 156 extending into recess 138, and contacting cradle component 150 may adjust, shift, move, and/or change the radial position of cradle component 150 between wheel housings 134 and/or over cross member 142. Additionally by contacting side surface 160 of cradle component

150, displacement components 156 may also apply opposite forces on cradle component 150 to maintain and/or secure cradle component 150 within wheel housings 134 of trolley 104. Although discussed herein as a threaded bolt, it is understood that displacement components 156 may be any component, assembly, and/or part that may be configured to adjust the position of cradle component 150 of trolley 104. For example, displacement components 156 may be hydraulic/pneumatic/mechanical jacks, pre-sized inserts or wedges, pins (e.g., clevis pin), and the like.

[0033] Additionally, trolley 104 may also include at least one other, distinct displacement component 162. As shown in FIG. 3, cross member 142 of trolley 104 may include displacement component 162 positioned within cross member 142. More specifically, displacement component 162 may be positioned within and/or through an aperture 164 formed through cross member 142, and displacement component 162 may extend partially above cross member 142 toward cradle component 150. Displacement component 162 may also be positioned adjacent to and may substantially contact a bottom surface 166 of cradle component 150. Displacement components 162 extending through cross member 142 may contact bottom surface 166 of cradle component 150 to adjust the position and/or height of cradle component 150. That is, displacement components 162 may contact bottom surface 166 of cradle component 150 to adjust the distance or separation between cradle component 150 and cross member 142, and to substantially raise or lower cradle component 150 from cross member 142 and/or rails 106 of installation apparatus 100.

[0034] In the non-limiting example shown in FIG. 3, and similar to displacement components 156 of wheel housing 134, displacement components 162 may be configured as threaded bolts. The threaded bolts forming displacement components 162 may be turned within aperture 164 formed through cross member 142 to either increase or decrease the length of the portion of displacement component 162 extending above cross member 142 and contacting bottom surface 166 of cradle component 150. Increasing and/or decreasing the length of the portion of displacement component 162 extending above cross member 142, and contacting cradle component 150 may adjust the distance or separation between cradle component 150 and cross member 142, and/or may raise, lift, and/or change the height of cradle component 150. Although discussed herein as a threaded bolt, it is understood that displacement components 162 may be any component, assembly, and/or part that may be configured to adjust the position or height of cradle component 150 of trolley 104. For example, displacement components 162 may be hydraulic/pneumatic/mechanical jacks, pre-sized inserts or wedges, pins, and the like.

[0035] FIG. 4 shows a perspective view of installation apparatus 100 of FIGs. 2A and 3, and a portion of diffuser 40 of gas turbine system 10 of FIG. 1. Specifically, FIG.

4 shows installation apparatus 100 positioned at least partially within and/or coupled to diffuser 40 of gas turbine system 10. It is understood that similarly numbered and/or named components may function in a substantially similar fashion. Redundant explanation of these components has been omitted for clarity.

[0036] As shown in FIG. 4, and as discussed herein, when installation apparatus 100 is positioned within and/or coupled to diffuser 40 and rails 106 of platform portion 102 of installation apparatus 100 may extend axially through a portion of diffuser 40 of turbine system 10. Specifically, rails 106 of installation apparatus 100 may extend axially through flow path opening 44 (hereafter, "opening 44") of diffuser 40 from adjacent turbine 28 (see, FIG. 1) toward generator 32. Additionally as discussed herein, a portion of rails 106 of installation apparatus 100 may be positioned within diffuser 40. As shown in FIG. 4, first distal end 108 (e.g., shown in phantom) of each rail 106 may be positioned within and/or may be substantially surrounded by diffuser 40. Additional portions of rails 106 of installation apparatus 100 may also extend outside of diffuser 40. For example, second distal end 110 of rails 106 of installation apparatus 100 may extend outside of, be positioned out of and/or may not be surrounded by diffuser 40. Second distal end 110 of rails 106 may also be positioned between diffuser 40 and generator 32 of turbine system 10 (see, FIG. 1).

[0037] As a result of second distal end 110 of rails 106 being positioned outside of diffuser 40, the plurality of supports 122 coupled to second distal end 110 may also be positioned outside of diffuser 40, and/or between diffuser 40 and generator 32 of turbine system 10. Furthermore, and as shown in FIG. 4, adjustable components 126 coupled to supports 122 may also be positioned between diffuser 40 and generator 32, and may contact and/or rest on a surface 46 to substantially support or substantially stabilize the plurality of supports 122 of installation apparatus 100. As discussed herein, the height of adjustable component 126 may be adjusted (e.g., lengthening threaded screw 130 - FIG. 2AB) to adjust the height and/or leveling support 122, as well as, to adjust the height, incline, and/or level the respective rails 106 of installation apparatus 100 that may be coupled to supports 122. During the installation process discussed herein, it may be desirable to adjust the incline of respective rails 106 of installation apparatus 100 using adjustable component 126 to be substantially level and/or in axial alignment with opening 44 of diffuser 40, or alternatively, to be at a slight incline where first distal end 108 of rails 106 are positioned radially above second distal end 110.

[0038] Briefly turning to FIG. 5, and with continued reference to FIG. 4, rail 106 may be coupled directly to diffuser 40. Specifically, and as shown in FIG. 5, coupling plate 112 formed or positioned at first distal end 108 of each rail 106 may be coupled directly to a portion 48 of diffuser 40 to couple and/or secure rails 106 of installation apparatus 100 to and/or within diffuser 40. In the non-

limiting example shown, coupling plate 112 may be directly and releasably coupled to portion 48 of diffuser 40 using fasteners (e.g., screws, bolts, rivets, and the like) to perform the installation process using installation apparatus 100. In another non-limiting example, coupling plate 112 may be fixed to portion 48 of diffuser 40 using a substantially permanent fixing technique (e.g., welding, brazing, melting, and so on) to secure rails 106 of installation apparatus 100 to diffuser 40 in order to perform the installation process discussed herein. Additionally, and as discussed herein, the geometry, size, and/or shape of coupling plate 112 may correspond and/or match a geometry of portion 48 of diffuser 40 to improve contact and coupling between coupling plate 112 and portion 48 of diffuser 40. Portion 48 of diffuser 40 may be a preexisting structure formed in diffuser 40, or alternatively, portion 48 may be formed in diffuser 40 for the purpose of allowing coupling plate 112 formed at first distal end 108 to couple rails 106 of installation apparatus 100 to diffuser 40.

[0039] Returning to FIG. 4, load-coupling 36 of turbine system 10 is positioned on and/or received by installation apparatus 100. More specifically, load-coupling 36 of turbine system 10 may be positioned on and/or substantially received by cradle component 150 of trolley 104 of installation apparatus 100. In the non-limiting example shown in FIG. 4, and as discussed herein, load-coupling 36 may be positioned on and/or substantially received by cradle component 150 of trolley 104 after load-coupling 36 is positioned, moved, and/or passed through opening 44 of diffuser 40, and received by cradle component 150. Additionally, and as discussed herein, load-coupling 36 received by and/or positioned on cradle component 150 of trolley 104 may be moved in an axial direction using trolley 104 positioned on rails 106, and/or may be moved in a radial direction by adjusting displacement components 156, 162 of trolley 104. This may substantially align load-coupling 36 with turbine portion 34 and generator portion 38 of rotor 30 (see, FIG. 1) of turbine system 10 and aid in coupling load-coupling 36 to the same.

[0040] FIGs. 6-8 show various views of another non-limiting example of installation apparatus 200. More specifically, FIG. 6 shows a perspective view of another non-limiting example of installation apparatus 200 including platform portion 202 and trolley(s) 204, FIG. 7 shows an exploded view of trolley 204 shown in FIG. 6, and FIG. 8 shows a perspective view of trolley 204 of FIG. 7. It is understood that similarly numbered and/or named components may function in a substantially similar fashion. Redundant explanation of these components has been omitted for clarity.

[0041] As shown in FIG. 6, and with comparison to FIG. 2A, platform portion 202 of installation apparatus 200 may include distinct configurations and/or structures. For example, rails 206 of platform portion 202 of installation apparatus 200 shown in FIG. 6 may be formed from two distinct portions 268A, 268B. First portion 268A may in-

clude first distal end 208 of rail 206, and second portion 268B may include second distal end 210 of rail 206, respectively. As such, first portion 268A may be coupled to diffuser 204 via coupling 212 formed at first distal end 210 (e.g., see, FIGs. 4 and 5), and second portion 268B may be coupled directly to supports 222. As shown in FIG. 6, first portion 268A and second portion 268B of rail 206 may be joined and/or coupled to one another at joint 270. In non-limiting examples, first portion 268A and second portion 268B may be releasably coupled (e.g., screws, bolt-and-nut, clamps, and the like) to one another at joint 270, or alternatively, may be affixed (e.g., brazed, welded, riveted, and the like) to one another at joint 270, to form rail 206 of installation apparatus 200.

[0042] Similar to rails 206, supports 222 shown in the non-limiting example of FIG. 6 may also be distinct from supports 122 shown and discussed herein with respect to FIG. 2A. That is, supports 222 of platform portion 202 of installation apparatus 200 shown in FIG. 6 may be formed from two distinct portions 272A, 272B. First portion 272A may include first end 224 of support 222, and second portion 272B may include second end 228 of support 222, respectively. As such, first portion 272A may be coupled second distal end 210 and/or second portion 268B of rail 206, and second portion 272B may be coupled directly to and/or may include adjustable component 226. As shown in FIG. 6, and also similar to rail 206, first portion 272A and second portion 272B of support 222 may be joined and/or coupled to one another at joint 274. In non-limiting examples, first portion 272A and second portion 272B may be releasably coupled to one another at joint 274, or alternatively, may be affixed to one another at joint 274, to form support 222 of installation apparatus 200.

[0043] Turning to FIGs. 7 and 8, and with continued reference to FIG. 6, trolley(s) 204 of installation apparatus 200 may include distinct and/or additional features, and/or structures as those discussed herein with respect to trolley 104 shown in FIGs. 2A and 3. For example, cradle component 250 may be formed from distinct portions 276A, 276B. That is, cradle component 250 may include two distinct portions 276A, 276B that may be coupled and/or affixed to one another. Each portion 276A, 276B of cradle component 250 may be positioned within, received by, and/or coupled to recess 238 formed in a respective or corresponding wheel housing 234 of trolley 204. In the non-limiting example, forming cradle component 250 from two distinct portions 276A, 276B may allow an operator performing the installation process to couple/form cradle component 250, and/or to position cradle component 250 within wheel housing 234 within diffuser 40 and/or after wheel housing 234 has been positioned on rails 206. This may be substantially beneficial where clearance and/or open space within diffuser 40 is substantially minimal.

[0044] As shown in FIGs. 7 and 8, wheel housings 234 of trolley 204 may also include wheel covers 278. Wheel covers 278 may be formed on, integral with, and/or ex-

tend from wheel housings 234 adjacent wheels 236. Additionally, wheel covers 278 may substantially surround wheels 236. As shown in the non-limiting example of FIGs. 7 and 8, wheel covers 278 may extend from all portions of wheel housing 234 except for inner surface 240, and may substantially surround wheels 236 on three sides. In the non-limiting example shown, wheel covers 278 may not extend adjacent inner 240 as a result of wheels 236, and/or inner surface 240 of wheel housing 234 contacting track 218 (see, FIG. 6) during the installation process discussed herein (e.g., avoid catching/obstruction). Wheel covers 278 may be formed on wheel housing 234 to prevent debris and/or foreign objects from undesirably contacting wheels 236 and/or being undesirably wedged between wheels 236 and wheel housing 234, which may result in wheels 236 being unable to axially move trolley 204 over rails 206, as discussed herein.

[0045] Trolley 204 may also include intermediate plate 280. Intermediate plate 280 may be positioned on and/or above cross member 242 of trolley 204. Additionally, and as shown in FIG. 7, intermediate plate 280 may be positioned between cross member 242 and cradle component 250 of trolley 204. Intermediate plate 280 may provide a component and/or surface to improve the movement of cradle component 250 within trolley 204. For example, when adjusting the radial position of cradle component 250 between wheel housings 234 using displacement components 256, top surface 282 of intermediate plate 280 may act as a flat, planar surface to allow cradle component 250 to move radially over. Additionally a layer of grease or lubricant (not shown) may be formed on top surface 282 of intermediate plate 280 to reduce friction between intermediate plate 280 and cradle component 250, and/or to ease the radial movement of cradle component 250, as discussed herein. Additionally, when increase or decrease the length of the portion of displacement component 262 extending above cross member 242, displacement component 262 may directly contact bottom surface 284 of intermediate plate 280, which may in turn adjust the distance or separation between cradle component 250 and cross member 242, and/or may raise, lift, and/or change the height of cradle component 250. As a result of intermediate plate 280 being formed as a single, unitary body, the stabilization (e.g., substantially level/planar/even) of cradle component 250 may be improved when adjust the distance or separation between cradle component 250 and cross member 242, and/or may raise, lift, and/or change the height of cradle component 250.

[0046] As shown in FIGs. 7 and 8, trolley 204 may also include at least one protective plate 286. More specifically, protective plate(s) 286 may be coupled to cradle component 250 of trolley 204. Protective plate(s) 286 may be formed on, cover, and/or coupled to cradle component 250 to reduce the wear imparted on and/or improve the operational life of cradle component 250. In the non-limiting example shown in FIGs. 7 and 8, protective plate(s) 286 may be formed on, cover, and/or coupled

to portions of cradle component 250 that may experience increased wear and/or strain as a result of the operation and/or function of trolley 204 during the installation process. For example, side surfaces 260 and bottom surface 266 of cradle component 250 may experience increased wear and/or strain as a result of displacement components 256, 262 interacting with these surfaces to adjust the position of cradle component 250 within wheel housings 234. As a result, and as shown in the non-limiting example shown in FIGs. 7 and 8, protective plate(s) 286 may be formed on, cover, and/or coupled to both side surface 260 and bottom surface 266 of cradle component 250 to reduce wear and/or improve operational life of cradle component 250. Although shown as a plurality of distinct plates, it is understood that protective plate(s) 286 may be formed as one or more protective plates. For example, protective plate(s) 286 may be formed as a single plate which covers both side surfaces 260 and the entirety of bottom surface 266 of cradle component 250. Alternatively, protective plate(s) 286 may include two distinct plates, where each plate covers one side surface 260 and at least a portion of bottom surface 266 of cradle component 250. Protective plate(s) 286 may be formed from any suitable material that may reduce wear and/or improve operational life of cradle component 250 including, but not limited to, metal, metal alloys, polymers, ceramics, or the like.

[0047] FIG. 9 shows an exploded view of another non-limiting example of trolley 304. Trolley 304 shown in FIG. 9 may be utilized within any installation apparatus 100, 200 discussed herein. It is understood that similarly numbered and/or named components may function in a substantially similar fashion. Redundant explanation of these components has been omitted for clarity.

[0048] Trolley 304 may include distinct and/or additional features, and/or structures as those discussed herein with respect to trolley 104, 204 shown in FIGs. 2A, 3, and 6-8, respectively. For example, and as shown in FIG. 9, cross member 342 of trolley 304 may include a distinct configuration and/or features. That is, cross member 342 may not include apertures 164, 264 formed therein (see, FIG. 3 and 7). Rather, cross member 342 may include two slots 388 formed therein. Slots 388 formed in cross member 342 may receive displacement component 362 of trolley 304. That is, each displacement component 362 may be positioned within, and/or substantially received by slot 388 formed in cross member 342.

[0049] In the non-limiting example shown in FIG. 9, displacement component 362 for trolley 304 may be configured and/or formed as a unique device, component and/or apparatus than displacement component 162, 262 discussed herein with respect to trolley 104, 204 (see, FIG. 3 and 7). Specifically, displacement components 362 positioned within slots 388 of cross member 342 may be configured or formed as lifts 390. Lifts 390 forming displacement components 362 may be hydraulic lifts, pneumatic lifts, mechanical lifts, or the like. Once actuated, lifts 390 may raise, elongate and/or increase

in size to adjust the distance or separation between cradle component 350 and cross member 342, and/or may raise, lift, and/or change the height of cradle component 350. To aid in the adjustment and/or the extendable height of displacement components 362/lifts 390 for adjusting cradle component 350, displacement components 362/lifts 390 may each include an optional shim plate 392 (shown in phantom). In a non-limiting example, shim plate 392 may be positioned on/above lift 390, and may contact bottom surface 366 and/or protective plates 386 directly when adjust the distance or separation between cradle component 350 and cross member 342, as discussed herein. In another non-limiting example (not shown), shim plate 392 may be positioned below each lift 390 and/or may be positioned within slots 388 of cross member 342 to add height to displacement components 362/lifts 390.

[0050] FIG. 10 shows non-limiting example processes for installing a load-coupling in a gas turbine system using an installation apparatus. Specifically, FIG. 10 is a flow-chart depicting example processes for coupling a load-coupling to distinct portions of a rotor of a gas turbine system using a platform portion and trolley(s) of an installation apparatus. In some cases, the processes may utilize various installation apparatuses, as discussed herein with respect to FIGs. 2A, 3, and 6-9.

[0051] In process P1, a casing surrounding a turbine of a gas turbine system may be removed. That is, at least a portion of a casing surrounding the turbine or turbine component of the gas turbine system may be removed. Removing at least a portion of the casing of the turbine may expose a diffuser of the gas turbine system. More specifically, removing at least a portion of the casing of the turbine may expose an opening of the diffuser and/or may provide access to the opening of the diffuser.

[0052] In process P2, an installation apparatus may be positioned within the diffuser of the turbine system. More specifically, an installation apparatus may be positioned at least partially within and may be substantially coupled to a portion of the diffuser of the turbine system. The installation apparatus may include a plurality of rails releasably coupled to and extending axially through a portion of the diffuser, toward a generator of the turbine system. Additionally the installation apparatus may include at least one trolley positioned on the plurality of rails. The trolley(s) may include a plurality of wheel housings, each wheel housing including at least one wheel slidably engaging a corresponding rail of the plurality of rails, and a cradle component positioned partially within each of the plurality of wheel housings. Additionally, the installation apparatus may include a plurality of supports coupled to the rails.

[0053] Positioning the installation apparatus at least partially within the diffuser of the turbine system in process P2 may include additional processes as well. For example, positioning the installation apparatus at least partially within the diffuser may include releasably coupling a coupling plate formed on a distal end of each of

the plurality of rails to the diffuser of the turbine system. The coupling plate may be releasably coupled to a portion of diffuser configured to receive, contact and/or be couple to the coupling plate formed on each rail of the installation apparatus. Positioning the installation apparatus at least partially within the diffuser may also include contacting each of the plurality of wheel housings of the trolley(s) with a corresponding track formed on and/or coupled to a top surface of each of the plurality of rails. The tracks may guiding the axial movement of the trolley(s), and/or prevent the trolley(s) from undesirably shifting in a radial direction and/or from being removed or falling off of the rails.

[0054] Additionally, positioning the installation apparatus at least partially within the diffuser may also include releasably coupling each of the plurality of supports of the installation apparatus to a corresponding rail of the plurality of rails. The plurality of supports may be positioned substantially perpendicular to and below the plurality of rails. Additionally, the plurality of supports may be positioned outside of the diffuser and/or between the diffuser and the generator of the turbine system. The plurality of supports may substantially support and/or stabilize the rails of the installation apparatus. Once releasably coupled to the rails, a height of each of the plurality of supports may be adjusted. The height of each of the plurality of supports may be adjusted using an adjustable component formed on an end of each support, opposite the corresponding rail of the plurality of rails. The adjustable component may adjust the height and/or level of the supports, as well as adjust the height, incline, and/or level the respective rails of the installation apparatus that may be coupled to each support.

[0055] In process P3, a load-coupling of the turbine system may be positioned on the cradle component of the at least one trolley of the installation apparatus. That is, the load-coupling may be positioned on and/or supported by the cradle component of the trolley(s) by moving the load-coupling through the diffuser adjacent the turbine or turbine component using the trolley(s). Positioning the load-coupling on the cradle component may include inserting a first end of the load-coupling into an opening of the diffuser that is adjacent the turbine of the system, and accessible as a result of removing at least a portion of the casing of the turbine as performed in process P1. Next, the load-coupling may be at least partially supported by placing a portion of the load-coupling on the cradle component of the trolley(s) of the installation apparatus. The load-coupling may then be moved through the opening in the diffuser and/or may be positioned within the diffuser by rolling the trolley(s) of the installation apparatus in a substantially axial direction over the plurality of rails. As a result of rolling the trolley(s) in the substantially axial direction, the load-coupling may be moved toward the generator of the turbine system to position the first end of the load-coupling substantially adjacent and/or axially aligned with the generator section of a rotor of the turbine system, and position the second

end of the load-coupling substantially adjacent and/or axially aligned with the turbine section of a rotor of the turbine system.

[0056] Positioning the load-coupling on the cradle component of the trolley(s) in process P3 may include additional processes as well. For example, once positioned on the cradle component, the radial position of the cradle component of the trolley(s) may be adjusted to axially align the load-coupling with the turbine section and/or generator section of the rotor for the turbine system. Adjusting the radial position of the cradle component of the trolley(s) may include adjusting the position of the cradle component between each of the plurality of wheel housings using a first displacement component included within at least one of the plurality of wheel housings of the trolley(s). Additionally, or alternatively, adjusting the radial position of the cradle component of the trolley(s) may include adjusting a distance between the cradle component and a cross member fixed to each of the plurality of wheel housings, below the cradle component, using a second displacement component included within the cross member. Adjusting the distance or separation between the cradle component and the cross member may result in the raising/lowering, and/or changing the height of the cradle component, and the load-coupling positioned on the cradle component.

[0057] In process P4, the load-coupling positioned on the cradle component of the trolley(s) of the installation apparatus may be coupled to various sections of the rotor of the turbine system. Specifically, once the load-coupling is positioned within the diffuser and the respective ends are positioned adjacent to and/or axially aligned with the turbine section and generator section of the rotor (e.g., process P3), the load-coupling may be coupled to the turbine section of the rotor, and the generator section of the rotor, respectively, to form a continuous rotor of the turbine system. The first end of the load-coupling may be coupled directly to the generator section of the rotor, and the second end of the load-coupling may be coupled directly to the turbine section of the rotor.

[0058] FIGs. 11-14 show a side view of a portion of turbine 28, diffuser 40, and load-coupling 36 of turbine system 10 undergoing an installation process using installation apparatus 200. The installation process for installing load-coupling 36 within turbine system 10 using installation apparatus 200 may correspond to the processes P1-P4 discussed herein with respect to FIG. 10. It is understood that similarly numbered and/or named components may function in a substantially similar fashion. Redundant explanation of these components has been omitted for clarity.

[0059] As shown in FIG. 11, a portion of casing 42 of turbine 28 for turbine system 10 has been removed. That is, a portion of casing 42 surrounding turbine 28, and turbine section 34 of rotor 20 may be substantially removed and may expose at least a portion of turbine 28, and turbine section 34 of rotor 20. Additionally, and as shown in FIG. 11, removing a portion of casing 42 of

turbine 28 may expose and/or provide access to an opening 44 of diffuser 40 from the side of diffuser adjacent turbine 28. That is, by removing a portion of casing 42, opening 44 of diffuser 40 may be accessible and/or exposed from both a side adjacent turbine 28, as well as, a downstream side of diffuser 40 adjacent generator 32. Removing at least a portion of casing 42, as shown in FIG. 11, may correspond to process P1 of FIG. 10.

[0060] Additionally as shown in FIG. 11, installation apparatus 200 may be positioned at least partially within diffuser 40. That is, rails 206, and more specifically coupling plate 212, of installation apparatus 200 may be coupled directly to portion 48 of diffuser 40, and rails 206 may extend axially through diffuser 40. Additionally, supports 222 may be coupled directly to rails 206 to support and/or stabilize rails 206 of installation apparatus 200. In the non-limiting examples, the height of each of the plurality of supports 222 may be adjusted using adjustable component 226 formed on end 228 of each support 222 and contacting surface 46. Specifically, and as shown in FIG. 11, adjustable component 226 may adjust the height and/or level of supports 222, as well as adjust the height, incline, and/or level the respective rails 206 of installation apparatus 200. Also shown in FIG. 11, two trolleys 204 may be positioned on the plurality of rails 206 extending axially through diffuser 40, and may be configured to slidably engage and/or move in an axial direction over rails 206 using wheels 236 (not shown). Positioning installation apparatus 200 at least partially within diffuser 40, as shown in FIG. 11, may correspond to process P2 of FIG. 10.

[0061] Additionally, FIG. 11 shows load-coupling 36 prior to being inserted, positioned, and/or moved through diffuser 40. As shown in FIG. 11, load-coupling 36 may be positioned adjacent and/or above turbine 28, and substantially adjacent and downstream of diffuser 40. In non-limiting examples, load-coupling 36 may be supported by a crane (not shown), or alternatively, by a user or operator performing the process of installing load-coupling 36 within turbine system 10 using installation apparatus 200.

[0062] FIGs. 12-14 show load-coupling 36 being positioned on cradle component 250 of trolleys 204 for installation apparatus 200. Specifically, FIGs. 12 and 13 show load-coupling 36 in distinct stages of being positioned within diffuser 40 using installation apparatus 200, and FIG. 14 shows load-coupling 36 positioned and/or supported on cradle component 250 of each trolley 204 of installation apparatus 200 and positioned between, and axially aligned with turbine section 34 and generator section 38 of rotor 20. With comparison to FIG. 11, FIGs. 12 and 13 show first end 50 of load-coupling 36 being positioned, moving, inserted, and/or passing through opening 44 of diffuser 40, adjacent turbine 28. That is, first end 50 of load-coupling 36 may be inserted into opening 44 of diffuser 40 adjacent turbine 28, opposite generator 32, and may be positioned and/or moved through diffuser 40 (axially) toward generator section 38 of rotor 20.

[0063] Once first end 50 of load coupling 36 is positioned within diffuser 40, a portion of load-coupling 36 may be received, positioned on, and/or substantially supported by cradle component 250 of trolley 204 for installation apparatus 200. Trolley 204 supporting and/or receiving load-coupling 36, via cradle component 250, may move in an axial direction over rails 106 toward generator section 38/generator 32 to move load-coupling through diffuser 40. That is, and with comparison between FIGs. 12-14, trolley(s) 204 of installation apparatus 200 may move in an axial direction over rails 106 to position and/or move load-coupling 36 within and/or through diffuser 40. Trolleys 204 may move axially with load-coupling 36 until first end 50 is positioned adjacent generator section 38 of rotor 20, and a second end 52 of load-coupling 36 is positioned adjacent turbine section 34 of rotor 20. Additionally, the radial position of cradle component 250 in each trolley 204 may be adjusted, using displacement components 256, 262 (see, FIGs. 7 and 8), to axially align load-coupling 36 with the adjacent sections of rotor 20. That is, the radial position of cradle component 250 in each trolley 204 may be adjusted to axially align first end 50 of load-coupling 36 with generator section 38 of rotor 20, and to axially align second end 52 of load-coupling 36 with turbine section 34 of rotor 20, respectively (see, FIG. 14). Positioning load-coupling 36 on cradle component 250 of trolleys 204 in installation apparatus 200 to move load-coupling 36 through diffuser 40, as shown in FIGs. 12-14, may correspond to process P3 of FIG. 10.

[0064] Finally as shown in FIG. 14, once load-coupling 36 is positioned on installation apparatus 200, positioned within diffuser 40, and/or axially aligned with the surrounding sections of rotor 20 using installation apparatus 200, load-coupling 36 may be coupled to generator section 38 and turbine section 34 of rotor 20, respectively. More specifically, first end 50 of load-coupling 36 may be coupled directly to generator section 38 of rotor 20, and second end 52 of load-coupling 36 may be coupled directly to turbine section 34 of rotor 20. Load-coupling 36 may be coupled to turbine section 34 and generator section 38 respectively to transfer and/or translate the rotation of rotor 20 at and/or downstream of turbine section 34 to generator section 38 to drive generator 32 (see, FIG. 1). Once load-coupling 36 is coupled to turbine section 34 and generator section 38 of rotor 20, installation apparatus 200 may be uninstalled, uncoupled, and/or removed from diffuser 40 prior to beginning operation of turbine system 10. Coupling load-coupling 36 to turbine section 34 and generator section 38 of rotor 20 of turbine system 10, as shown in FIG. 14, may correspond to process P4 of FIG. 10.

[0065] The technical effect is to provide installation apparatuses that are capable of aiding in the installation of load-couplings within turbine systems that have minimal or tight clearance (e.g., 2-3 meters) between a diffuser and a generator.

[0066] The foregoing drawings show some of the processing associated according to several embodi-

ments of this disclosure. In this regard, each drawing or block within a flow diagram of the drawings represents a process associated with embodiments of the method described. It should also be noted that in some alternative implementations, the acts noted in the drawings or blocks may occur out of the order noted in the figure or, for example, may in fact be executed substantially concurrently or in the reverse order, depending upon the act involved. Also, one of ordinary skill in the art will recognize that additional blocks that describe the processing may be added.

[0067] 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. "Optional" or "optionally" means that the subsequently described event or circumstance may or may not occur, and that the description includes instances where the event occurs and instances where it does not.

[0068] Approximating language, as used herein throughout the specification and claims, may be applied to modify any quantitative representation that could permissibly vary without resulting in a change in the basic function to which it is related. Accordingly, a value modified by a term or terms, such as "about," "approximately" and "substantially," are not to be limited to the precise value specified. In at least some instances, the approximating language may correspond to the precision of an instrument for measuring the value. Here and throughout the specification and claims, range limitations may be combined and/or interchanged, such ranges are identified and include all the sub-ranges contained therein unless context or language indicates otherwise. "Approximately" as applied to a particular value of a range applies to both values, and unless otherwise dependent on the precision of the instrument measuring the value, may indicate +/- 10% of the stated value(s).

[0069] The corresponding structures, materials, acts, and equivalents of all means or step plus function elements in the claims below are intended to include any structure, material, or act for performing the function in combination with other claimed elements as specifically claimed. The description of the present disclosure has been presented for purposes of illustration and description, but is not intended to be exhaustive or limited to the disclosure in the form disclosed. Many modifications and variations will be apparent to those of ordinary skill in the art without departing from the scope and spirit of the disclosure. The embodiment was chosen and described in order to best explain the principles of the disclosure and

the practical application, and to enable others of ordinary skill in the art to understand the disclosure for various embodiments with various modifications as are suited to the particular use contemplated.

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Parts list

	gas turbine system	10
	compressor	12
	air	18
10	compressed air	20
	combustor	22
	fuel	24
	combustion gases	26
15	turbine	28
	rotor	30
	electrical generator	32
	turbine portion	34
	load - coupling	36
20	generator portion	38
	diffuser	40
	casing	42
	flow path opening	44
25	surface	46
	portion	48
	first end	50
	second end	52
	installation apparatus	100
30	platform portion	102
	trolley	104
	rails	106
	distal ends	108
35	distal ends	110
	coupling plate	112
	track	118
	top surface	120
	support	122
40	first end	124
	adjustable component	126
	second end	128
	threaded screw	130
45	stabilizer foot	132
	wheel housing	134
	wheel	136
	recess	138
	inner surface	140
50	cross member	142
	projections	144
	fasteners	146
	apertures	148
55	cradle component	150
	contact surface	152
	curved geometry	154
	displacement component	156

(continued)

Claims

aperture	158		
side surface	160		
distinct displacement component	162	5	1. An installation apparatus (100) for a load-coupling (36) of a turbine system (10), the installation apparatus (100) comprising:
aperture	164		
bottom surface	166		a plurality of rails (106) extending axially through a portion (44) of a diffuser (40) of the turbine system (10), each of the plurality of rails (106) including:
installation apparatus	200	10	
platform portion	202		
trolley	204		
rail	206		
first distal end	208		a first distal end (108) positioned within and releasably coupled to the diffuser (40); and
second distal end	210		a second distal end (110) positioned opposite the first distal end (108); and
coupling	212	15	
track	218		
supports	222		at least one trolley (104) positioned on the plurality of rails (106), the at least one trolley (104) including:
first end	224		
adjustable component	226	20	
second end	228		a plurality of wheel housings (134) each wheel housing (134) including at least one wheel (136) slidably engaging a corresponding rail (106) of the plurality of rails (106); and
wheel housing	234		a cradle component (150) positioned partially within each of the plurality of wheel housings (134), the cradle component (150) for receiving the load-coupling (36) of the turbine (10) system.
adjacent wheels	236		
recess	238		
inner surface	240	25	
cross member	242		
cradle component	250		
displacement components	256		
side surface	260	30	
displacement component	262		
apertures	264		
bottom surface	266		2. The installation apparatus (100) of claim 1, wherein each of the plurality of rails (106) further includes:
joint	270		
joint	274	35	
wheel covers	278		a track (118) extending between the first distal end (108) and the second distal, the track (118) receiving and guiding an axial movement of the at least one wheel (136) of the wheel housing (134) slidably engaging the corresponding rail (106) of the plurality of rails (106).
intermediate plate	280		
top surface	282		
bottom surface	284		
protective plate	286	40	
trolley	304		
cross member	342		3. The installation apparatus (100) of claim 1, further comprising:
cradle component	350		
displacement component	362	45	
bottom surface	366		a plurality of supports (122) positioned substantially perpendicular to and substantially below the plurality of rails (106), each of the plurality of supports (122) including a first end (124) releasably coupled to a corresponding rail (106) of the plurality of rails (106).
protective plates	386		
slots	388		
lifts	390		
Shim plate	392	50	
first portion	268A		
second portion	268B		
first portion	272A		
second portion	272B		
distinct portions	276A	55	
distinct portions	276B		4. The installation apparatus (100) of claim 3, wherein each of the plurality of supports (122) further includes:
			an adjustable component (126) formed on a second end (128) of the support (122), opposite the first end (124), the adjustable component (126)

- configured to at least one of adjust the height of the support (122), or level the support (122).
5. The installation apparatus (100) of claim 1, wherein each of the plurality of rails (106) further includes:
- 5 a coupling plate (112) formed at the first distal end (108) of the rail (106), the coupling plate (112) directly coupled to the diffuser (40).
- 10
6. The installation apparatus (100) of claim 1, wherein at least one wheel (136) housing of the plurality of wheel housings (136) of the at least one trolley (104) includes:
- 15 a displacement component (156) positioned adjacent and contacting the cradle component (150), the displacement component (156) adjusting the position of the cradle component (150) between each of the plurality of wheel housings (136).
- 20
7. The installation apparatus (100) of claim 1, wherein the at least one trolley (104) further includes:
- 25 a cross member (142) fixed to each of the plurality of wheel housings (134), the cross member (142) positioned below the cradle component (150); and
- 30 at least one displacement component (162) positioned in the cross member (142), the at least one displacement component (162) adjusting a distance between the cradle component (150) and the cross member (142).
- 35
8. The installation apparatus (100) of claim 1, wherein the cradle component (150) of the at least one trolley (104) includes:
- 40 a contact surface (152) contacting the load-coupling (36) of the turbine system (10), the contact surface (152) including a curved geometry (154) substantially corresponding to a curvature of the load-coupling (36) of the turbine system (10).
- 45
9. A method of installing a load-coupling (36) in a turbine system (10) using an installation apparatus (100), the method comprising:
- 50 positioning the installation apparatus (100) at least partially within a diffuser (40) of the turbine system (10), the installation apparatus (100) including:
- 55 a plurality of rails (106) releasably coupled to and extending axially through a portion (44) of the diffuser (40), toward a generator (32) of the turbine system (10); and
- at least one trolley (104) positioned on the plurality of rails (106), the at least one trolley (104) including:
- a plurality of wheel housings (136), each wheel (136) housing including at least one wheel (136) slidably engaging a corresponding rail (106) of the plurality of rails (106); and
- a cradle component (150) positioned partially within each of the plurality of wheel housings (136);
- positioning the load-coupling (36) of the turbine system (10) on the cradle component (150) of the at least one trolley (104) of the installation apparatus (100) by moving the load-coupling (36) through the diffuser (40) adjacent a turbine (28) of the turbine system (10) using the at least one trolley (104) of the installation apparatus (100); and
- coupling the load-coupling (36) of the turbine system (10) to at least one of:
- a turbine section (28) of a rotor (30) of the turbine system (10), or
- a generator section (32) of the rotor (30) of the turbine system (10).
10. The method of claim 9, further comprising:
- adjusting a radial position of the cradle component (150) of the at least one trolley (104) to axially align the load-coupling (36) with at least one of the turbine section (28) of the rotor (30) or the generator section (32) of the rotor (30) prior to coupling the load-coupling (36) to at least one of the turbine section (28) of the rotor (30) or the generator section (32) of the rotor (30).
11. The method of claim 10, wherein adjusting the radial position of the cradle component (150) further includes at least one of:
- adjusting the position of the cradle component (150) between each of the plurality of wheel housings (136) using a first displacement component (156) of at least one of the plurality of wheel housings (136), or
- adjusting a distance between the cradle component (150) and a cross member (142) fixed to each of the plurality of wheel housings (136), below the cradle component (150), using a second displacement component (162) of the cross member (142).
12. The method of claim 9, wherein positioning the load-

coupling (36) of the turbine system (10) on the cradle component (150) of the at least one trolley (104) of the installation apparatus (100) further includes:

inserting a first end (50) of the load-coupling (36) 5
into an opening (44) of the diffuser (40) adjacent the turbine section (28) of the turbine system (10);
supporting the load-coupling (36) by placing a 10
portion of the load-coupling (36) on the cradle component (150) of the at least one trolley (104) of the installation apparatus (100); and
moving the load-coupling (36) through the open- 15
ing (44) of the diffuser (40) by rolling the at least one trolley (104) in a substantially axial direction over the plurality of rails (106) and toward the generator (32) of the turbine system (10) to:

position the first end (50) of the load-cou- 20
pling (36) substantially adjacent the gener-
ator section (32) of the rotor (30); and
position a second end (52) of the load-cou-
pling (36), opposite the first end (50), sub- 25
stantially adjacent the turbine section (28)
of the rotor (30).

13. The method of claim 9, wherein positioning the in- 30
stallation apparatus (100) at least partially within the
diffuser (40) of the turbine system (10) further in-
cludes:

releasably coupling a coupling plate (112)
formed on a distal end (108) of each of the plu-
rality of rails (106) to the diffuser (40) of the tur- 35
bine system (10); and
contacting each of the plurality of wheel hous-
ings (136) of the at least one trolley (104) with
a corresponding track (118) formed on each of
the plurality of rails (106), the track (118) guiding 40
the axial movement of the at least one trolley
(104).

14. The method of claim 9, wherein positioning the in- 45
stallation apparatus (100) at least partially within the
diffuser (40) of the turbine system (10) further in-
cludes:

releasably coupling each of a plurality of sup- 50
ports (122) to a corresponding rail (106) of the
plurality of rails (106), the plurality of supports
(122) positioned substantially perpendicular to
the plurality of rails (106) and positioned be-
tween the diffuser (40) and the generator (32)
of the turbine system (10). 55

15. The method of claim 14, further comprising:

adjusting a height of each of the plurality of sup-

ports (122) using an adjustable component
(126) formed on an end of each support (122),
opposite the corresponding rail (106) of the plu-
rality of rails (106).

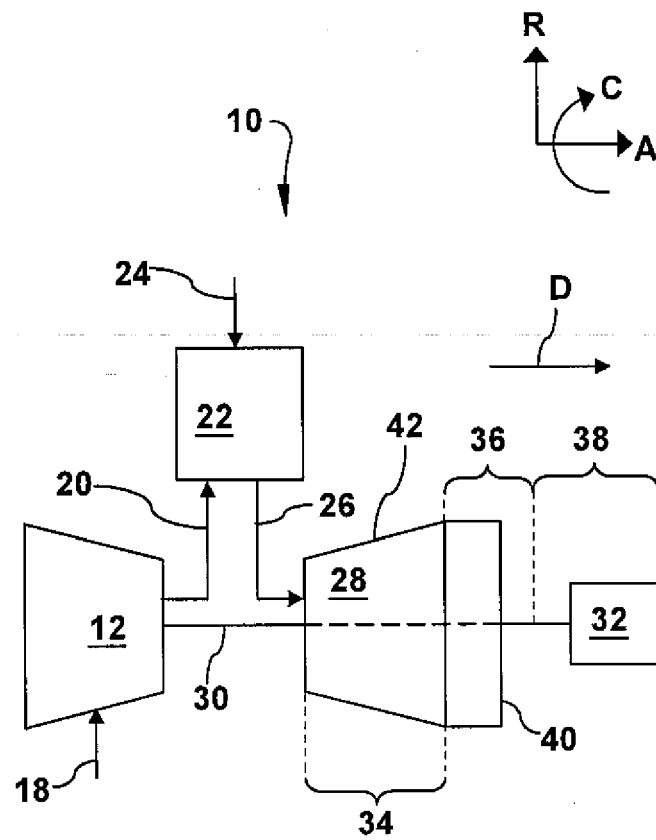
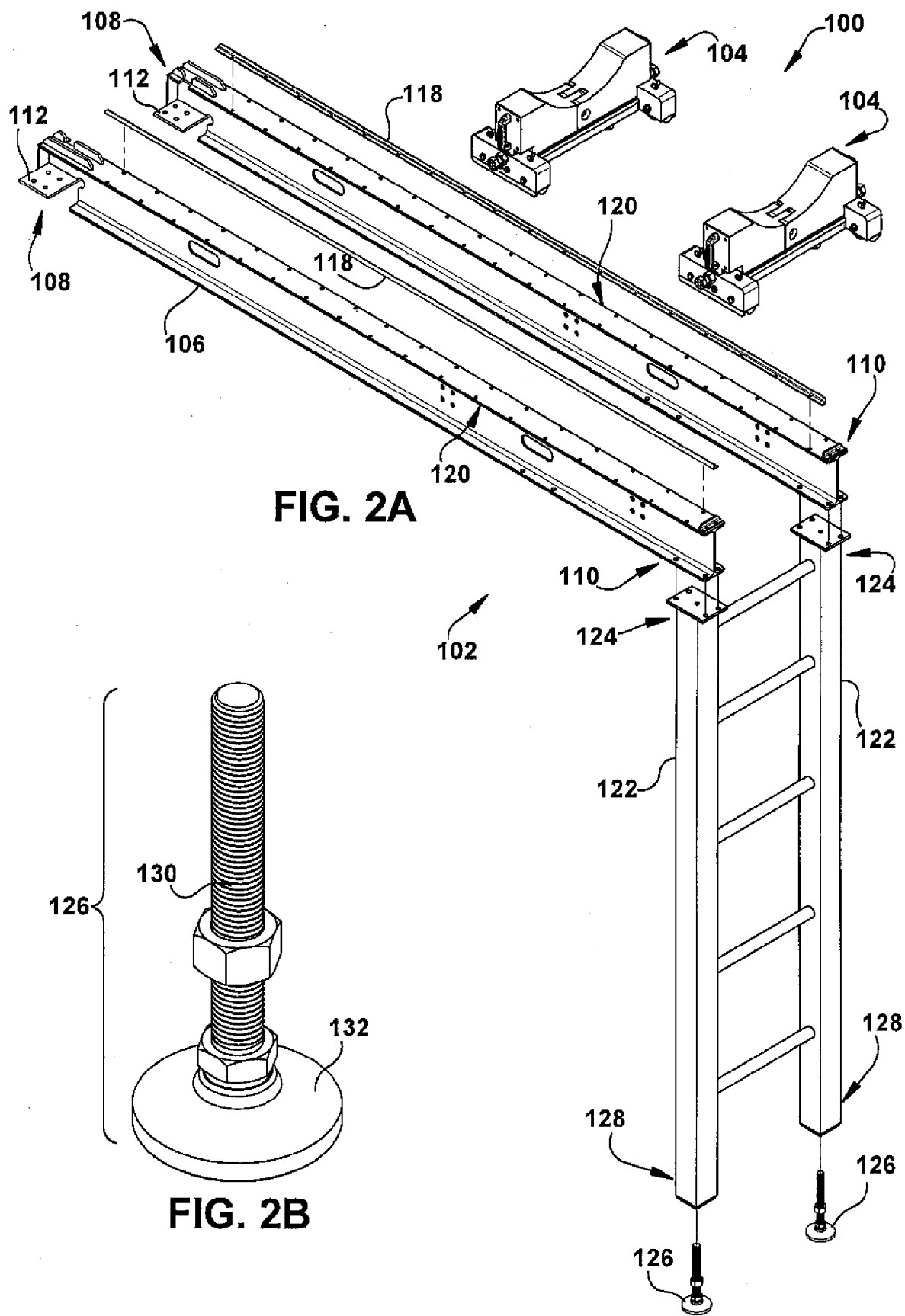


FIG. 1



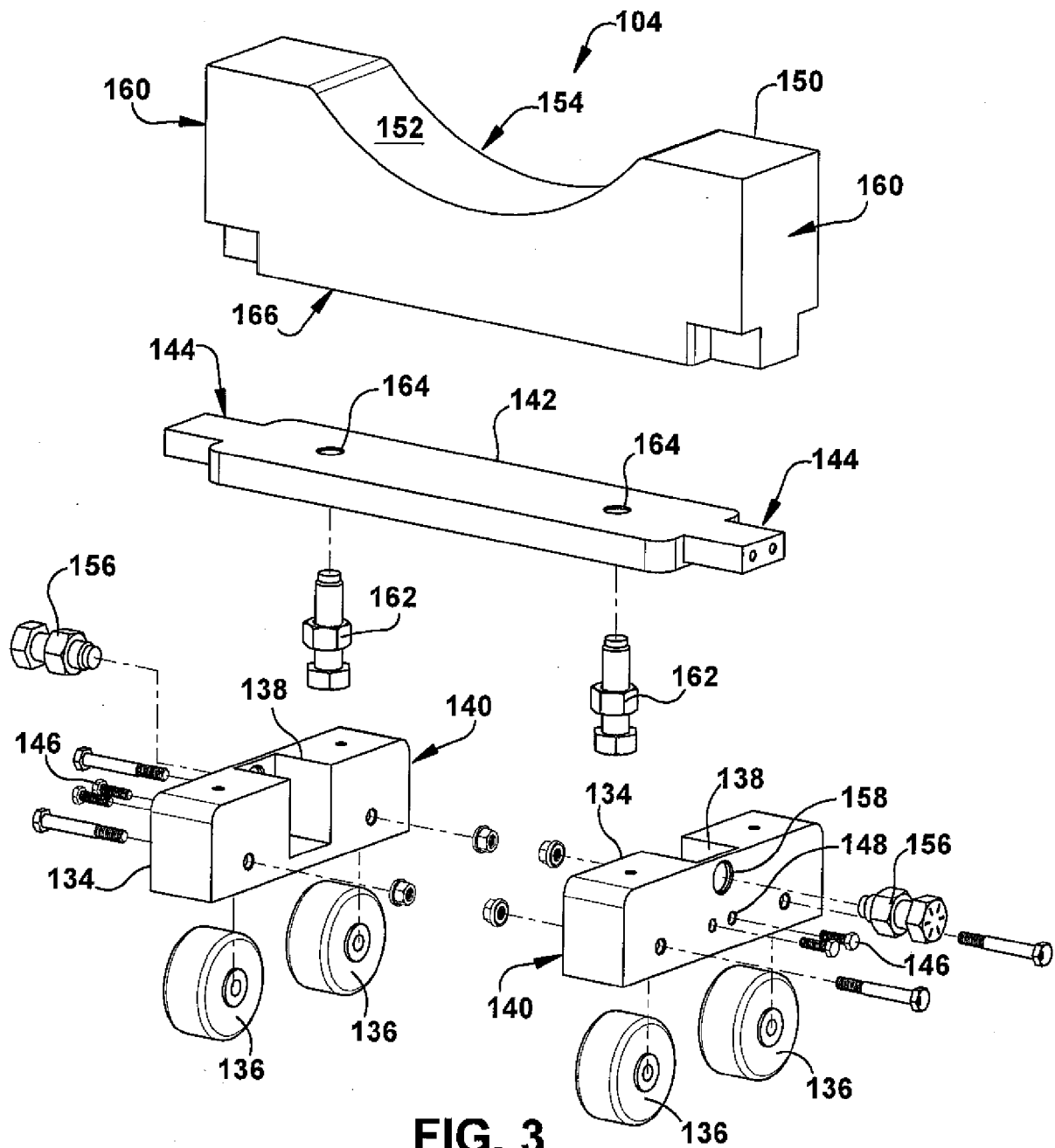
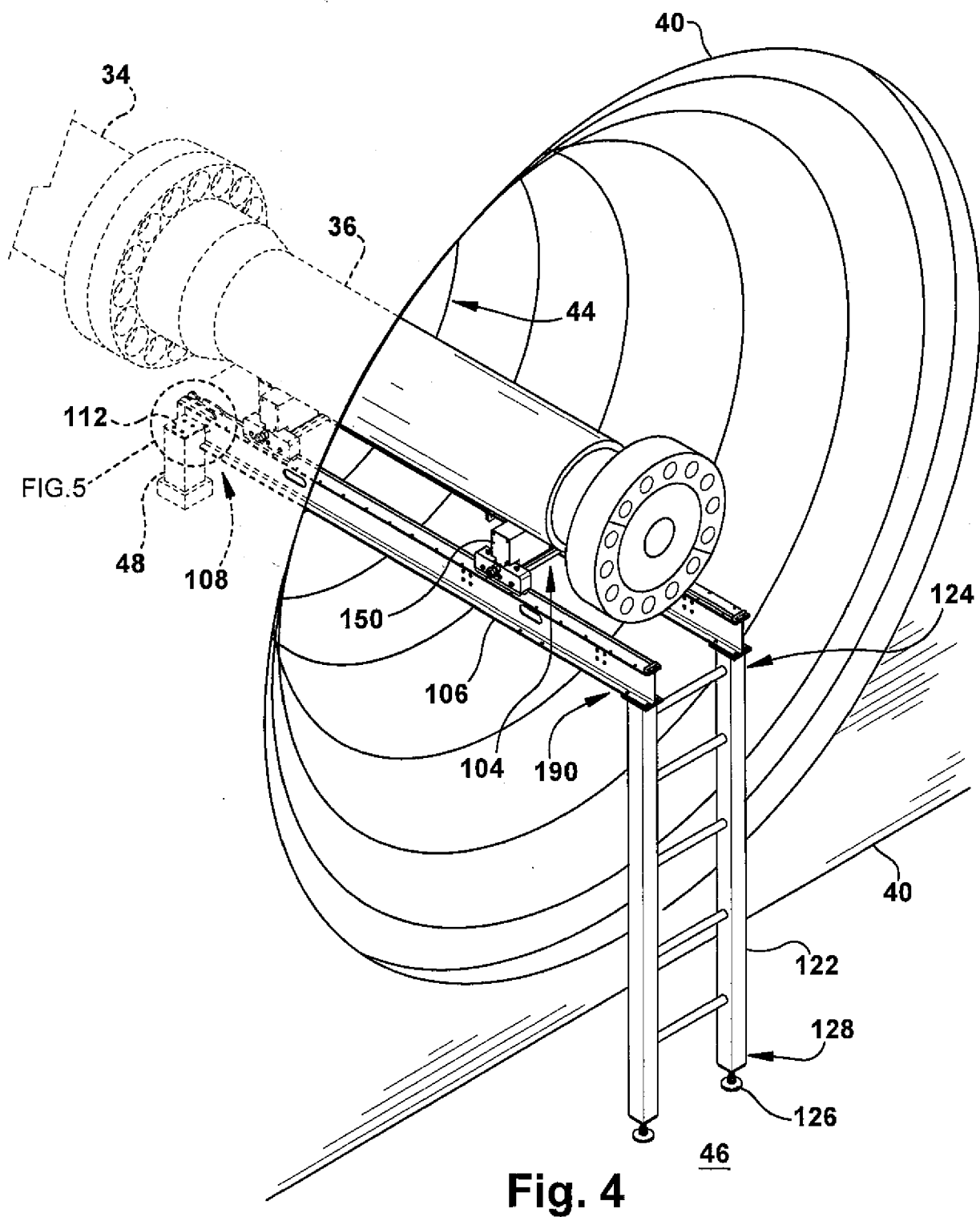


FIG. 3



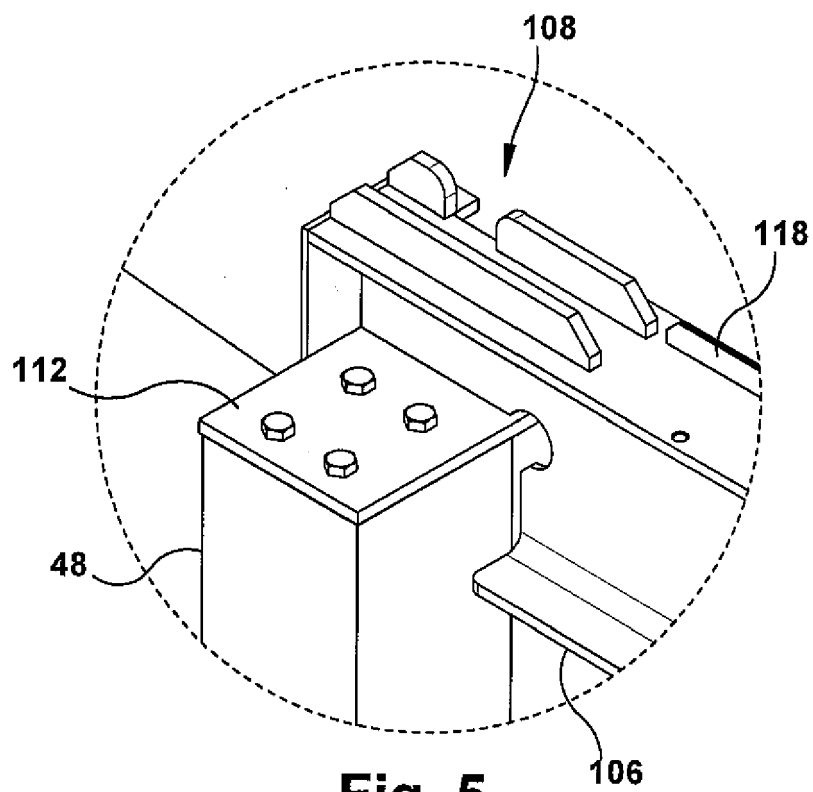
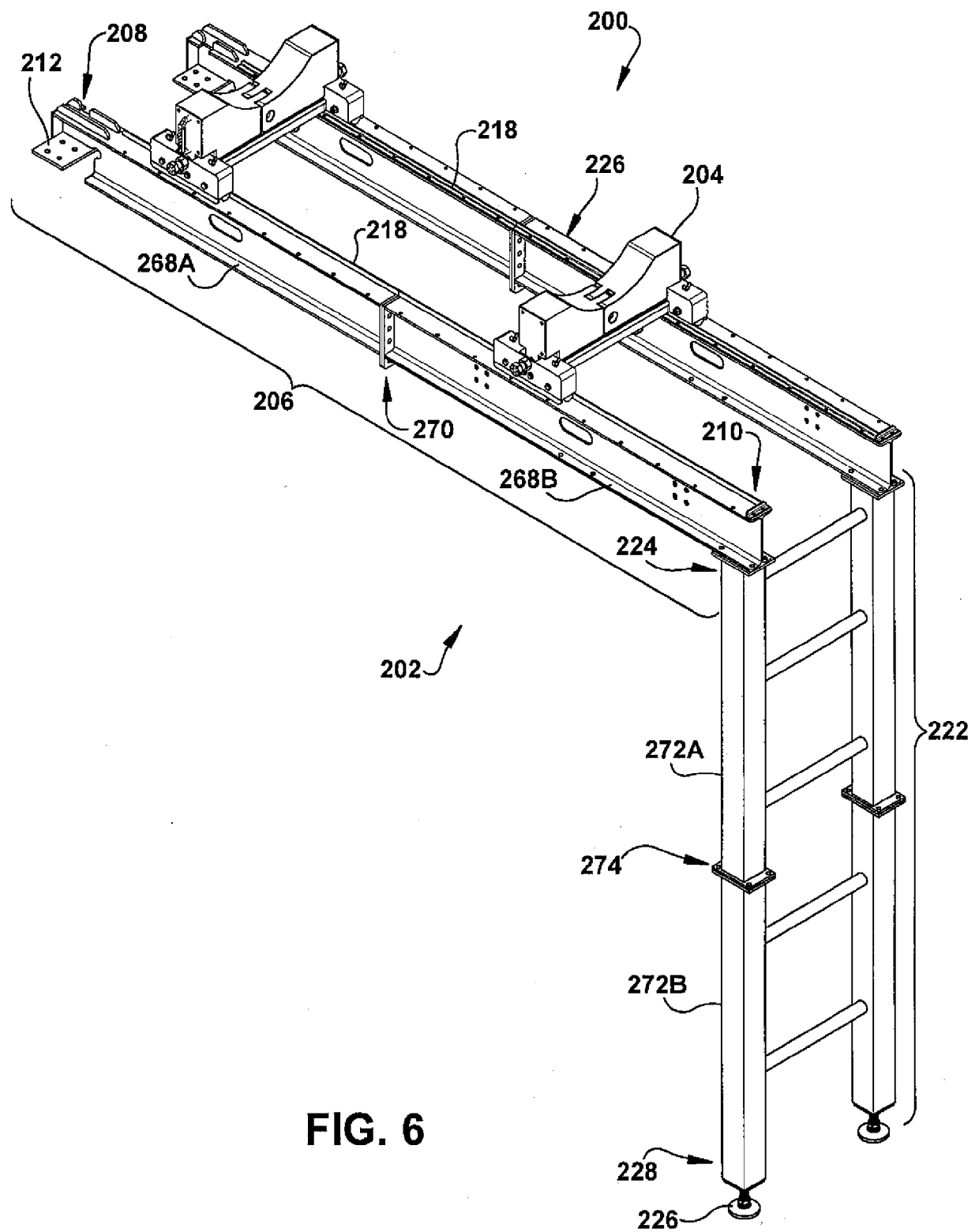


Fig. 5



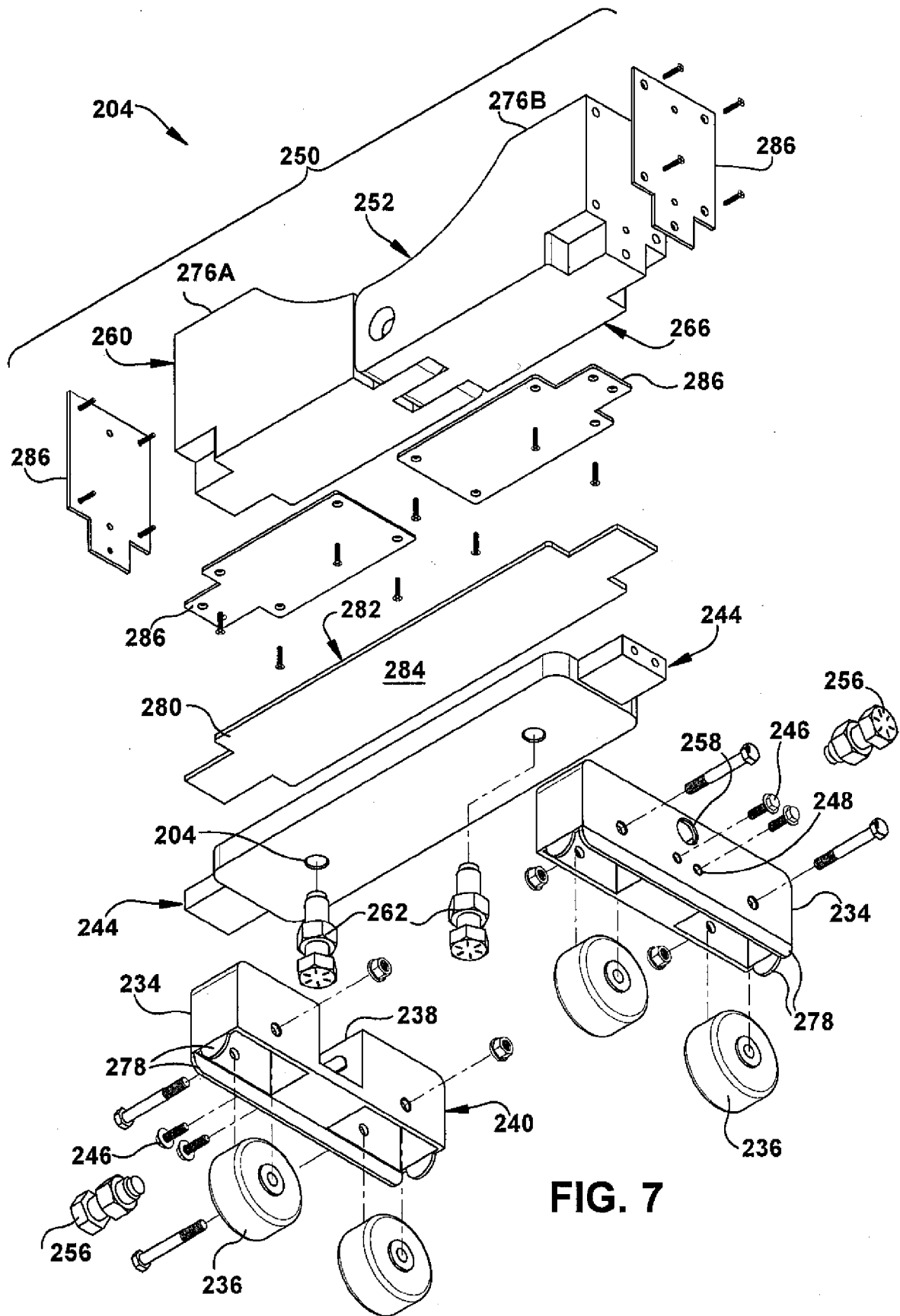
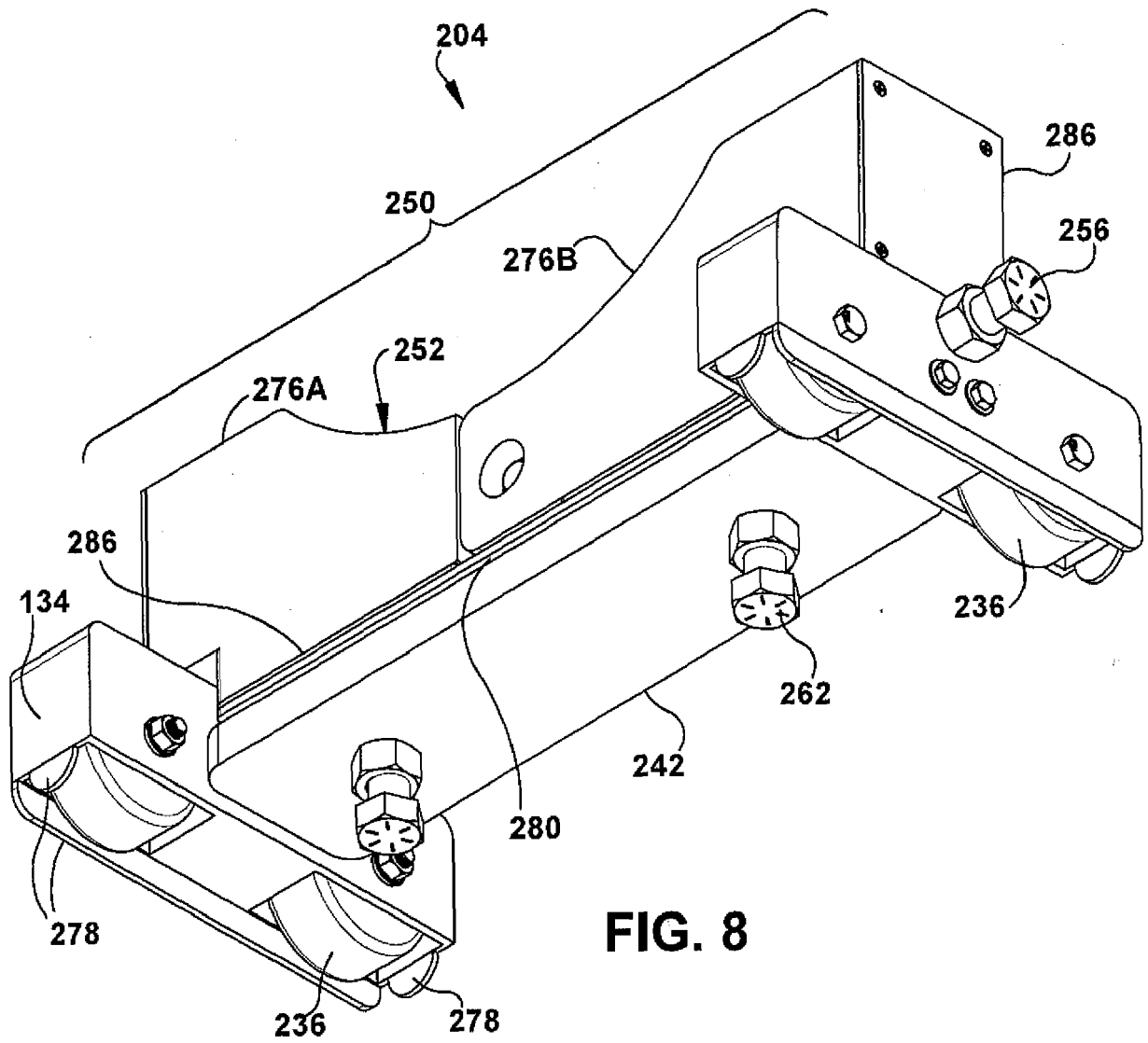
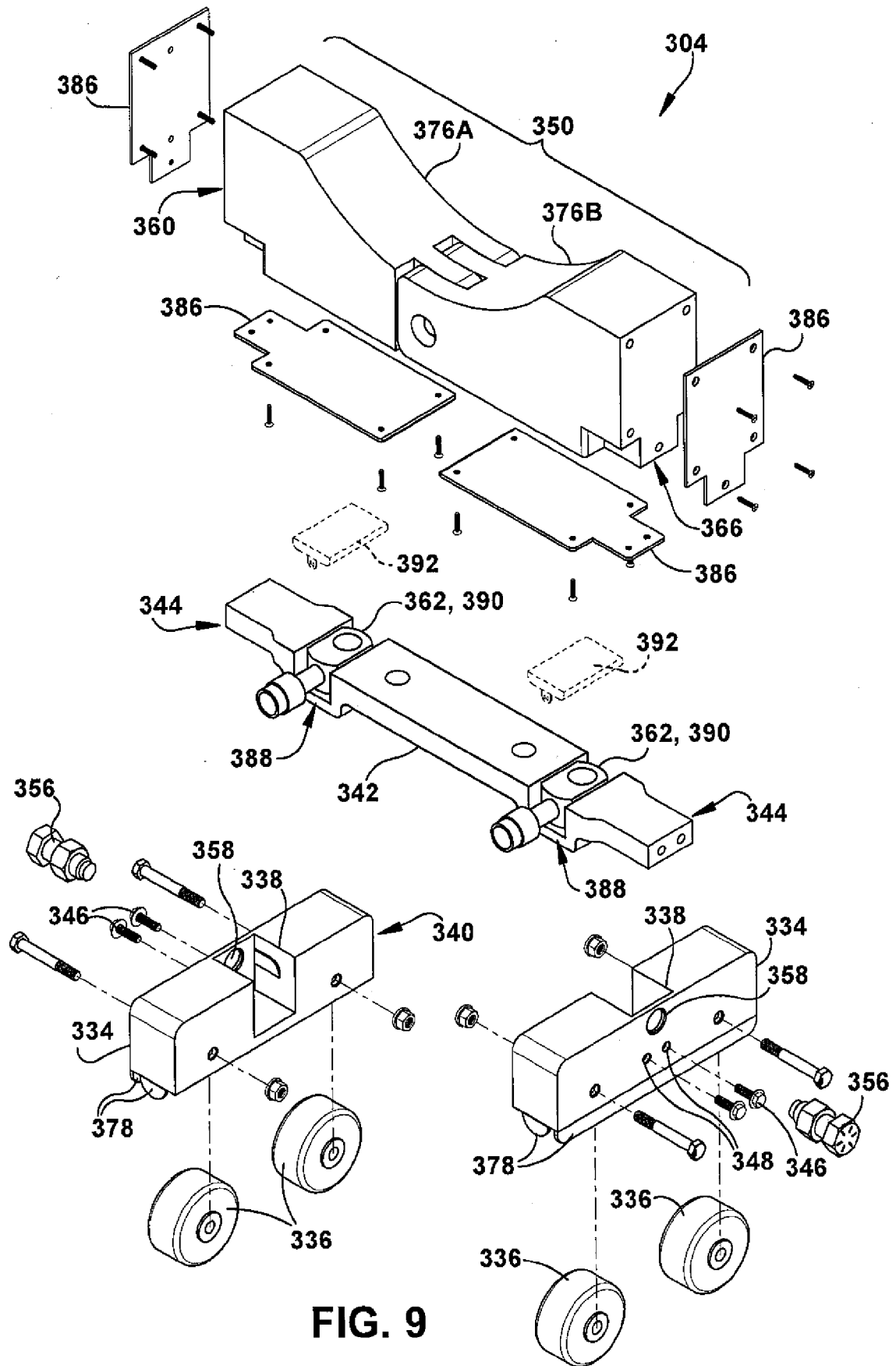


FIG. 7





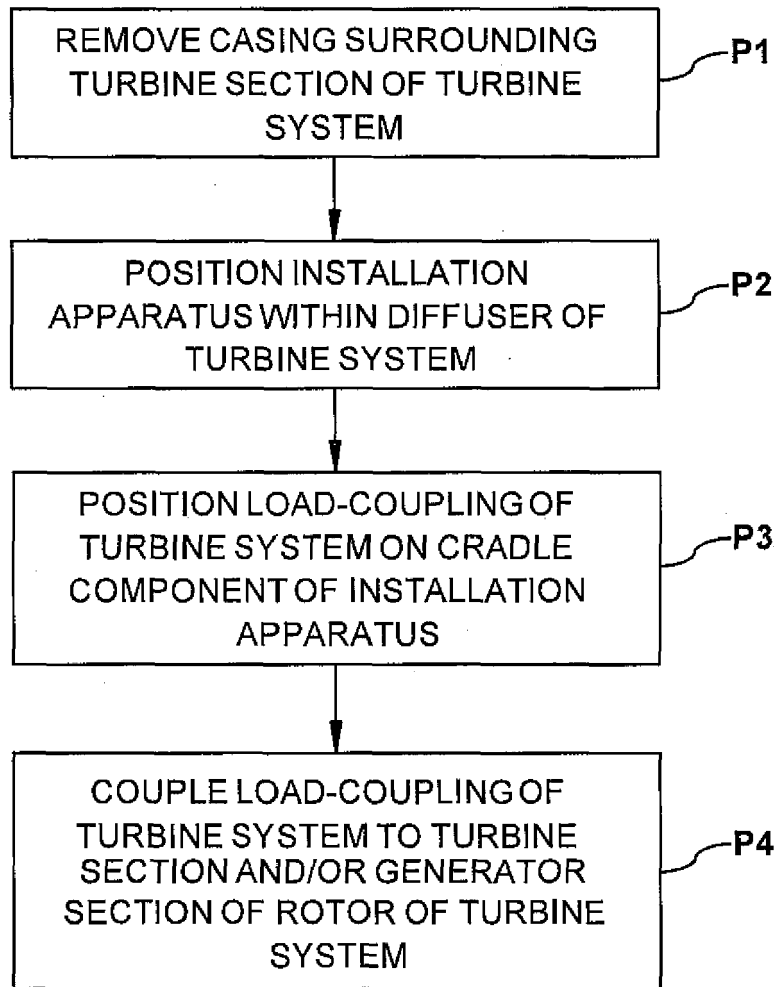


FIG. 10

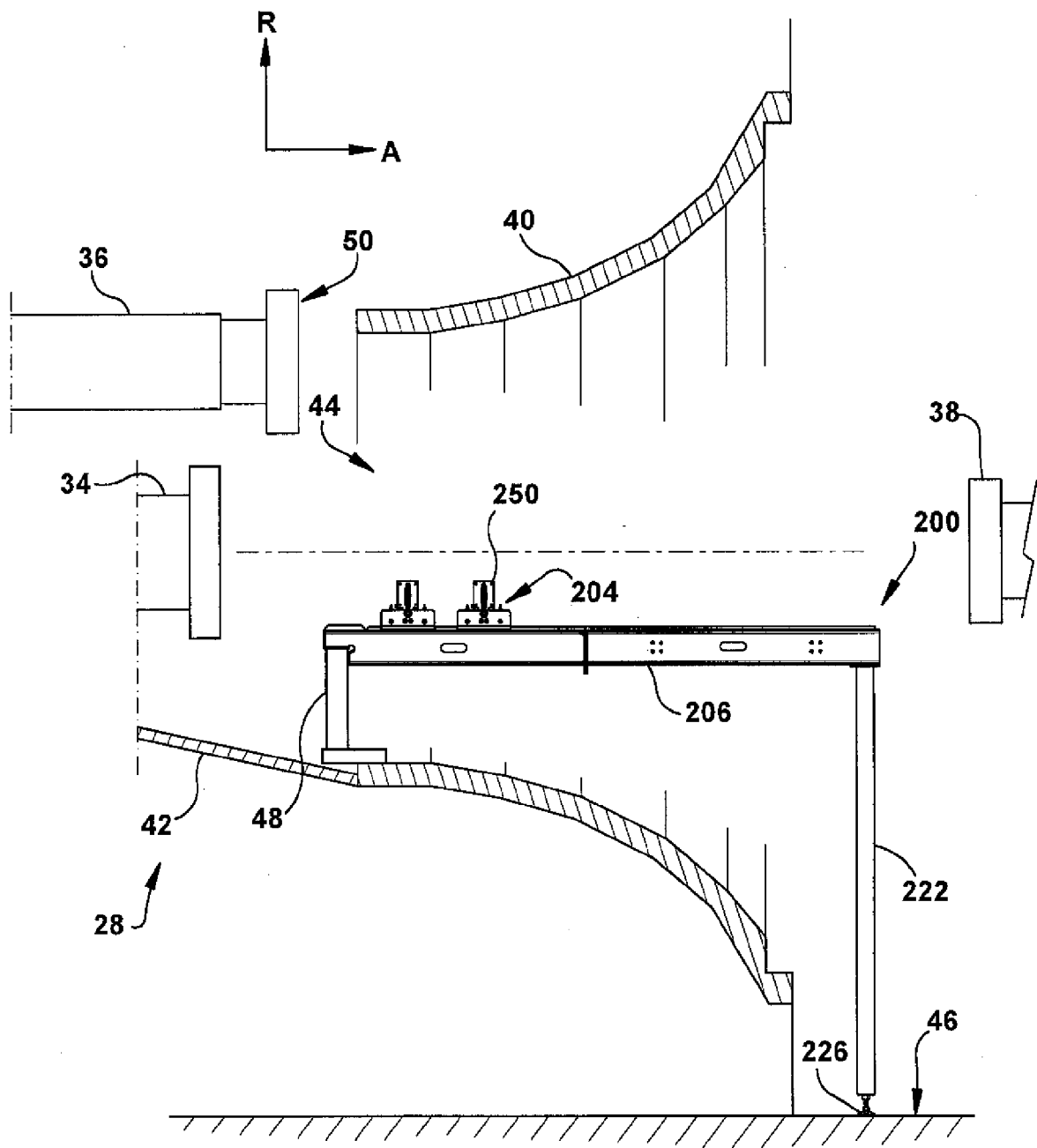


FIG. 11

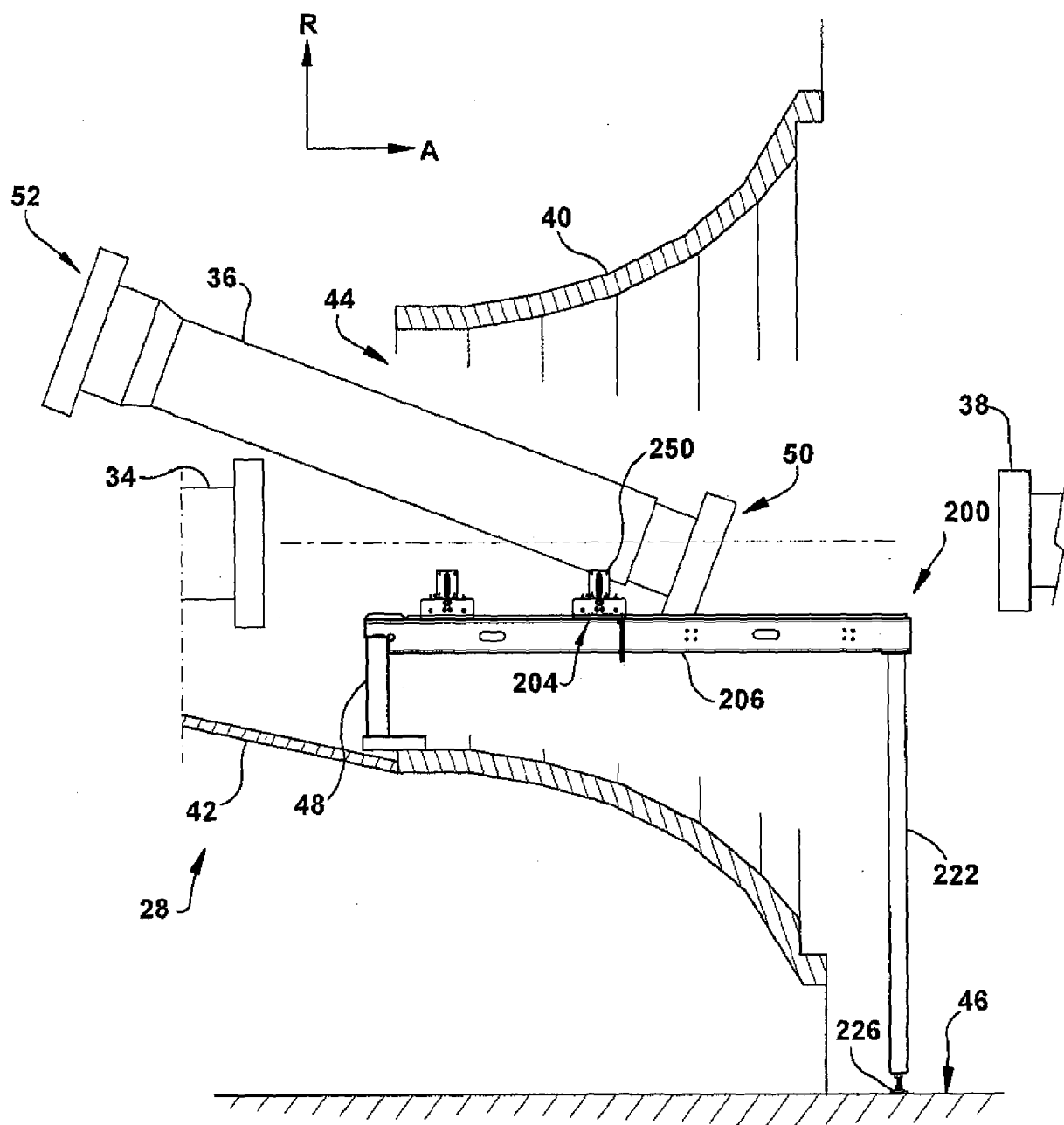


FIG. 12

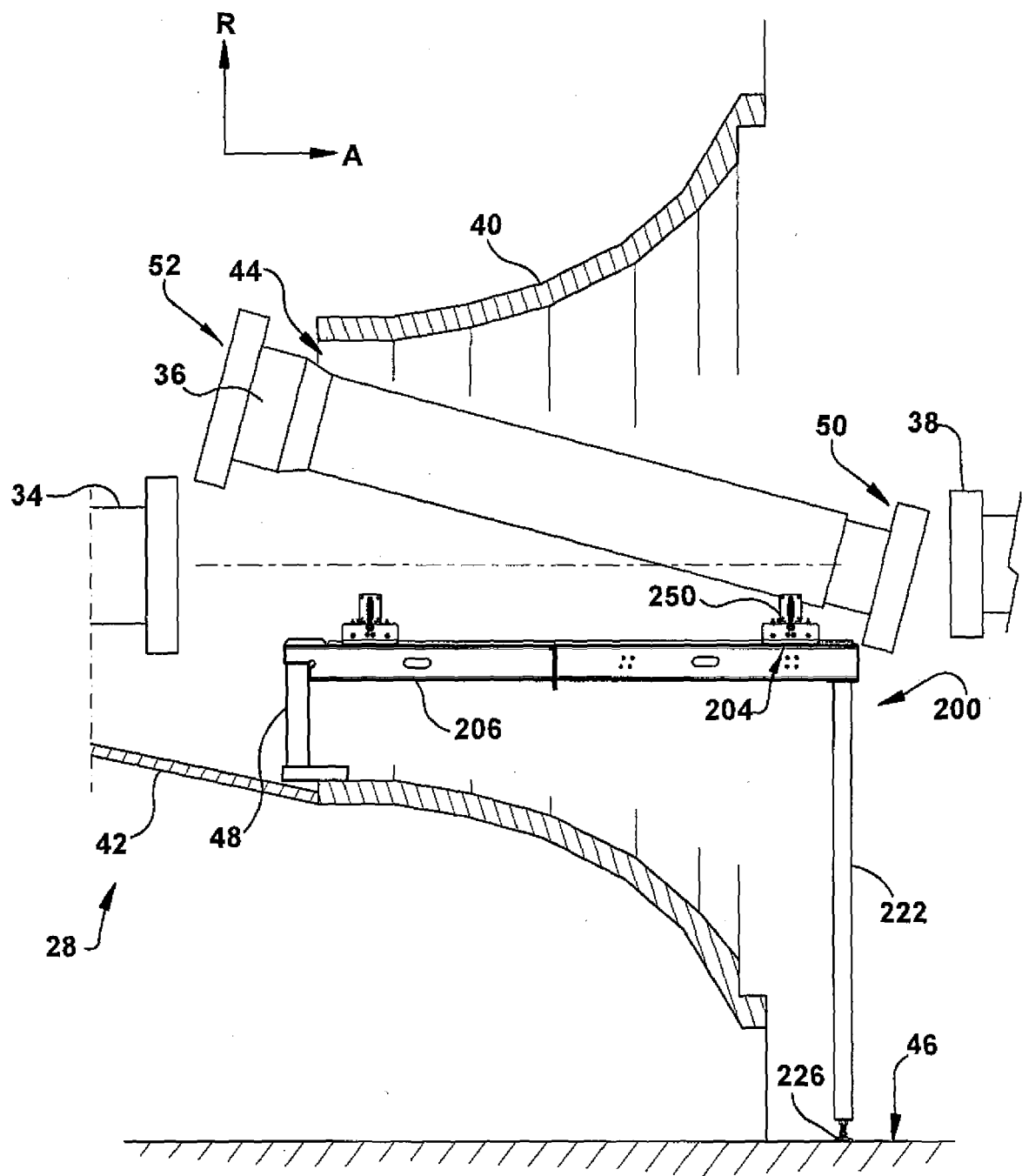


FIG. 13

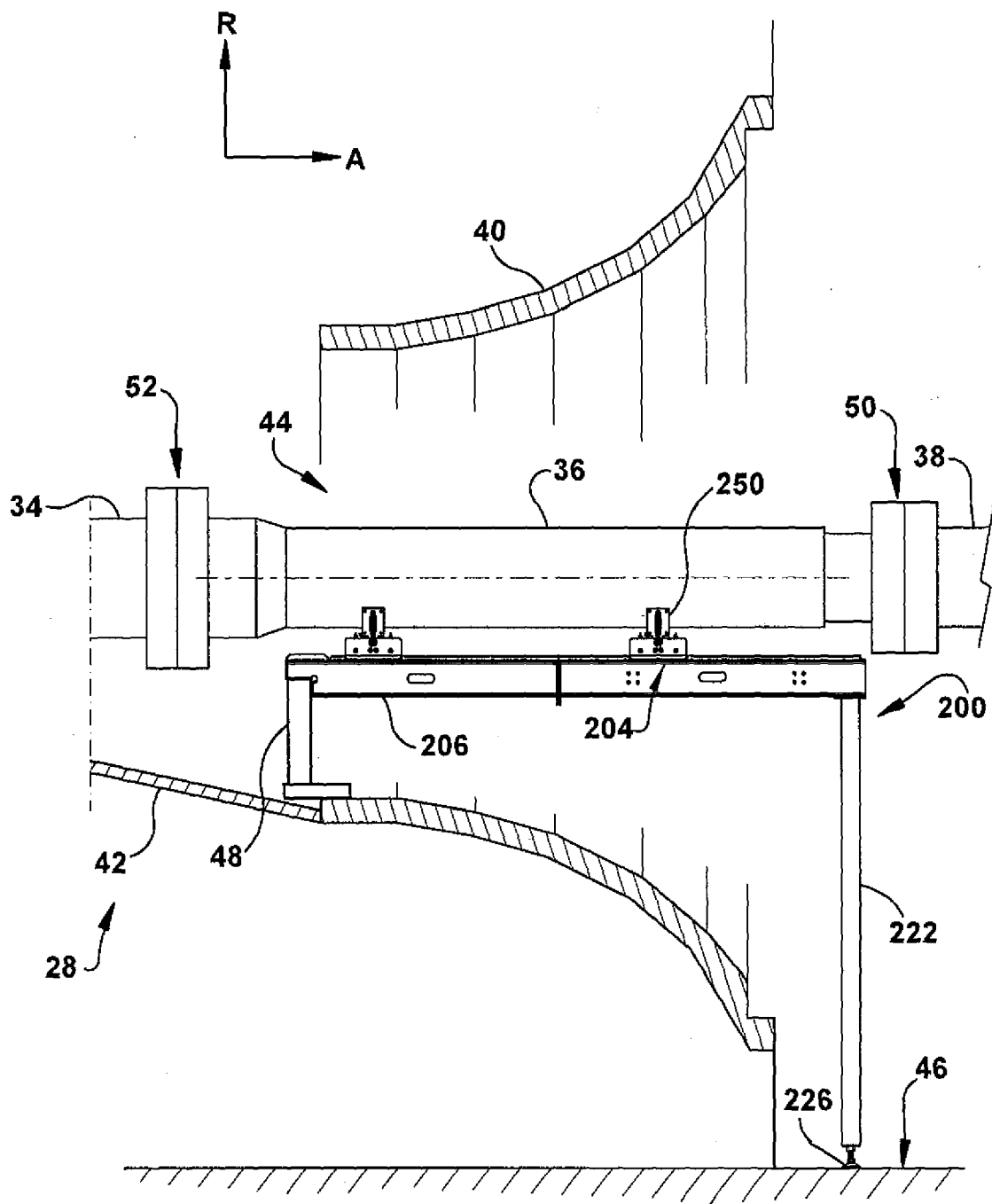


FIG. 14



EUROPEAN SEARCH REPORT

Application Number
EP 17 46 1629

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DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	EP 0 051 178 A1 (CARRIER CORP [US]) 12 May 1982 (1982-05-12) * the whole document * -----	1-15	INV. F01D25/28
			TECHNICAL FIELDS SEARCHED (IPC)
			F01D
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 11 April 2018	Examiner Lutoschkin, Eugen
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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