



- (51) **International Patent Classification:**
B08B 9/08 (2006.01) *B08B 9/093* (2006.01)
- (21) **International Application Number:**
PCT/US2014/027169
- (22) **International Filing Date:**
14 March 2014 (14.03.2014)
- (25) **Filing Language:** English
- (26) **Publication Language:** English
- (30) **Priority Data:**
MI2013A000389 15 March 2013 (15.03.2013) IT
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(81) **Designated States** (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) **Designated States** (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Published:

— with international search report (Art. 21(3))

(54) **Title:** TANK CLEANING MODULE ALIGNMENT SYSTEM AND RELATED METHODS

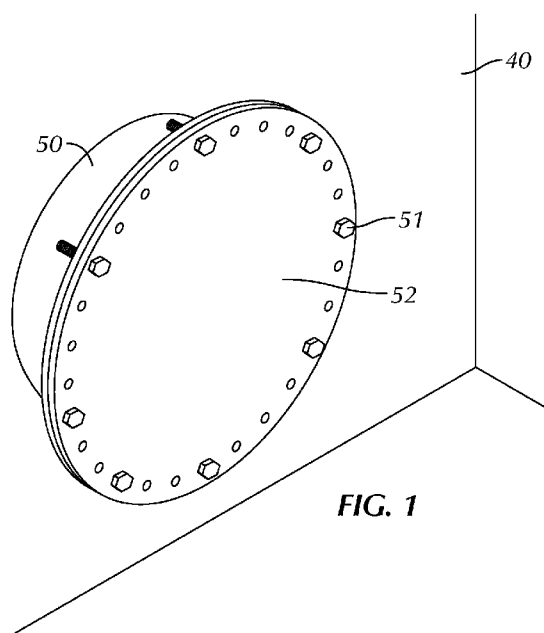


FIG. 1

(57) **Abstract:** An apparatus includes a frame structure and a guide beam, a moveable device coupled to the guide beam, a support structure coupled to the frame structure and configured to engage a body of a cleaning module, and a cleaning jet coupled to the moveable device and configured to move along the guide beam into the body of the cleaning module. A method includes coupling a cleaning module to a frame structure, the cleaning module having a body and a cleaning jet, and coupling the body of the cleaning module to the tank. The cleaning jet is moveably suspended from a guide beam supported by the frame structure and the body of the support structure is secured to the frame structure. A system includes a tank, a module having a body and a cleaning jet, and a frame structure having a guide beam and a trolley.

TANK CLEANING MODULE ALIGNMENT SYSTEM AND RELATED METHODS

BACKGROUND

[0001] Fluid storage tanks are used all over the world in refineries, terminals, and tank farms for storing oil products. The storage tanks are subjected to periodical cleaning operations due to sludge accumulation (which may lead to loss of operational capacity, loss of working time, and/or acceleration of corrosion in the storage tank), inspection and maintenance. Traditional cleaning systems are often based on manual removal of sludge, which may entail a number of challenges during execution, for example, health and safety risks, high volumes of waste to be disposed of, and prolonged tank shutdown times.

[0002] Equipment used to separate sludge and clean the large storage tanks are typically inserted into the storage tank through a manway (*i.e.*, opening) located in an outer shell of the tank. Proper alignment of a cleaning module inserted into the tank may be needed because the module is sized to prevent leaking of material from the tank when inserted through the manway. A crane or forklift is often used to lift the module to the manway with a single strap on which the module is balanced. Several workers then guide the module through the manway to maintain alignment, which is a tedious and potentially dangerous process. For example, often the area around the tank is uneven and/or has piping or other objects obstructing the pathway to the manway.

BRIEF DESCRIPTION OF DRAWINGS

[0003] Figure 1 shows a perspective view of a manway of a storage tank in accordance with one or more embodiments of the present disclosure.

[0004] Figure 2 shows a perspective view of a manhole adaptor attached to a manway of a storage tank in accordance with one or more embodiments of the present disclosure.

- [0005]** Figure 3 shows a perspective view of a cleaning module in an alignment system prior to insertion into the storage tank in accordance with one or more embodiments of the present disclosure.
- [0006]** Figure 4 shows a perspective view of a cleaning module inserted into the storage tank in accordance with one or more embodiments of the present disclosure.
- [0007]** Figure 5 shows an exploded view of an alignment system in accordance with one or more embodiments of the present disclosure.
- [0008]** Figure 6 shows a side view of an alignment system in accordance with one or more embodiments of the present disclosure.
- [0009]** Figure 7 shows a top view of an alignment system in accordance with one or more embodiments of the present disclosure.
- [0010]** Figure 8 shows an end view of an alignment system in accordance with one or more embodiments of the present disclosure.
- [0011]** Figure 9 shows an end view of an alignment system in accordance with one or more embodiments of the present disclosure.

DETAILED DESCRIPTION

- [0012]** The following is directed to various exemplary embodiments of the disclosure. Although one or more of these embodiments may be preferred, the embodiments disclosed should not be interpreted, or otherwise used, as limiting the scope of the disclosure, including the claims. In addition, those having ordinary skill in the art will appreciate that the following description has broad application, and the discussion of any embodiment is meant only to be exemplary of that embodiment, and not intended to suggest that the scope of the disclosure, including the claims, is limited to that embodiment.
- [0013]** Certain terms are used throughout the following description and claims refer to particular features or components. As those having ordinary skill in the art will appreciate, different persons may refer to the same feature or component by different

names. This document does not intend to distinguish between components or features that differ in name but not function. The figures are not necessarily to scale. Certain features and components herein may be shown exaggerated in scale or in somewhat schematic form and some details of conventional elements may not be shown in interest of clarity and conciseness.

[0014] In the following discussion and in the claims, the terms “including” and “comprising” are used in an open-ended fashion, and thus should be interpreted to mean “including, but not limited to” Also, the term “couple” or “couples” is intended to mean either an indirect or direct connection. Thus, if a first component is coupled to a second component, that connection may be through a direct connection, or through an indirect connection via other components, devices, and connections. Further, the terms “axial” and “axially” generally mean along or parallel to a central or longitudinal axis, while the terms “radial” and “radially” generally mean perpendicular to a central longitudinal axis.

[0015] Additionally, directional terms, such as “above,” “below,” “upper,” “lower,” etc., are used for convenience in referring to the accompanying drawings. In general, “above,” “upper,” “upward,” and similar terms refer to a direction toward the earth's surface from below the surface along a borehole, and “below,” “lower,” “downward,” and similar terms refer to a direction away from the surface along the borehole, *i.e.*, into the borehole, but is meant for illustrative purposes only, and the terms are not meant to limit the disclosure.

[0016] Embodiments disclosed herein relate generally to fluid storage tanks. In particular, embodiments disclosed herein relate to apparatuses and methods for cleaning fluid storage tanks. In one aspect, embodiments disclosed herein relate to a cleaning module alignment system configured to maneuver and align a cleaning jet prior to inserting the cleaning jet into a storage tank. Prior to inserting the cleaning jet, a sludge mapping and characterization process may be performed, which may include thermographic, density, and viscosity profiles that are taken to determine the quantity of sludge in the storage tank. In addition, characterization processes may be performed,

including sampling, density and viscosity profiles, and analysis of the sludge to allow for an optimal tank cleaning strategy to be developed. Examples and further description of sludge mapping and characterization processes may be disclosed in co-pending International Application No. PCT/EP2012/070335 (published as WO 2013/053921), assigned to the assignee of the present disclosure, and hereby incorporated by reference in its entirety.

[0017] Embodiments disclosed herein relate to an apparatus including a frame structure having a guide beam, a moveable device coupled to the guide beam, a support structure coupled to the frame structure and configured to engage a body of a cleaning module, and a cleaning jet coupled to the moveable device and configured to move along the guide beam into the body of the cleaning module. An adjustable linkage may be fastened between the moveable device and the cleaning jet. A second adjustable linkage may be fastened between the moveable device and the cleaning jet. The (first) adjustable linkage and the second adjustable linkage may be independently adjustable, such that a height (suspended or otherwise) of the (first) adjustable linkage and a height of the second adjustable linkage may be different or the same.

[0018] According to one or more embodiments of the present disclosure, a method may include coupling a cleaning module having a body and a cleaning jet to a frame structure, and coupling the body of the cleaning module to a tank. The coupling the cleaning module to the frame structure may include moveably suspending the cleaning jet from a guide beam, the guide beam supported by the frame structure, and securing the body with a support structure of the frame structure.

[0019] A system may include a tank, a cleaning module removably coupled to the tank, the module including a body and a cleaning jet, and a frame structure having a guide beam and a trolley moveably coupled to the guide beam, the cleaning jet coupled to the trolley. A support structure may be coupled to the frame structure and configured to receive the body of the module. The system may be used to align the cleaning jet with the body of the module and/or a manway of the tank. A winch device having a cable, the cable extending therefrom and coupled to the cleaning jet, may be coupled to the body of

the cleaning module, the tank, or the frame structure to assist in movement of the trolley, and therefore the cleaning jet, along the guide beam.

[0020] In accordance with one or more embodiments of the present disclosure, a system to provide axial alignment between a cleaning jet and a fixed cylinder of a cleaning module may include a frame structure supporting a guide beam, a roller mechanism coupled to the guide beam, wherein the cleaning jet is configured to be suspended from the roller mechanism, and a support structure configured to secure a first end of the fixed cylinder.

[0021] A method of aligning a storage tank cleaning module may include suspending a cleaning jet from a roller mechanism coupled to a guide beam, the guide beam supported by a frame structure, securing a fixed cylinder with a support structure of the frame structure, aligning a central axis of the cleaning jet with a central axis of the fixed cylinder, and inserting the cleaning jet within the fixed cylinder.

[0022] A system in accordance with embodiments disclosed herein may include a cleaning jet having a central axis, and a fixed cylinder having a central axis. A frame structure includes a guide beam with a roller mechanism coupled to the guide beam and the cleaning jet is suspended from the roller mechanism, a support structure has a first end of the fixed cylinder secured therein with the support structure including a cradle configured to correspond with at least a portion of an outer surface of the fixed cylinder. A winch device has a cable extending therefrom with the cable coupled to the fixed cylinder, in which the central axis of the cleaning jet is aligned with the central axis of the fixed cylinder.

[0023] An apparatus, system, and method according to embodiments disclosed herein relate to providing axial alignment between a cleaning jet and a fixed cylinder of a cleaning module. The system may include a frame structure supporting a guide beam, a roller mechanism coupled to the guide beam, wherein the cleaning jet is configured to be suspended from the roller mechanism, and a support structure configured to secure a first end of the fixed cylinder.

[0024] Referring initially to Figures 1 and 2, perspective views of a storage tank manway 50 (*i.e.*, an opening through which access to the internal volume of the storage tank is provided) and manhole adaptor 60 in accordance with one or more embodiments of the present disclosure are shown. After mapping and characterization processes have been performed, and a strategy has been determined for cleaning the storage tank, a process known as “cold tapping” may be performed. This process involves preparation prior to a cleaning jet being inserted into the storage tank. As shown, the manway 50 has a cover 52 (*e.g.*, a plate) secured to the storage tank with multiple fasteners (*e.g.*, bolts). Without opening the tank, several bolts may be removed from the manway 50, leaving a certain number of bolts 51 (*e.g.*, eight) in place to secure the cover 52. Those skilled in the art will appreciate that while eight bolts remain in this example, any number of bolts may remain in other examples.

[0025] Next, a manhole adaptor 60 having a central bore 61 and a gasket (not shown) to engage the manway 50, is placed over the manway 50 and secured thereto by way of larger holes in the manhole adaptor flange which fit over the remaining manway cover bolts 51. The manhole adaptor 60 may include a front valve 62 and two side valves 64 installed thereon. The valves 62, 64 are closed and the manhole adaptor 60 is pressure tested. Finally, a cold-tapping device (not shown) is bolted onto the manhole adaptor 60. The cold-tapping device includes a cutting device that is configured to protrude axially through the central bore 61 of the manhole adaptor 60. The front valve 62 may then be opened and the cutting device cuts into and through the manway cover 52, thereby providing access inside the storage tank.

[0026] Referring briefly now to Figure 3, a perspective view of a cleaning module 70 suspended in an alignment system 100 in accordance with one or more embodiments of the present disclosure is shown. After the cold-tapping device cuts through the manway cover, the cold tapping device may be removed and replaced by the cleaning module 70. The cleaning module 70 may include two individual main components: a body for coupling the cleaning module to a tank and a cleaning jet. For example, with reference to Figure 3, the cleaning module 70 may include a body, such as a fixed cylinder 70b having a central bore therethrough, configured to be attached to the manhole adaptor 60. In

addition, the cleaning module 70 may include a cleaning jet 70a that is suspended in the alignment system 100 and is configured to be aligned with the fixed cylinder 70b and inserted therethrough into the storage tank 40. Although shown as suspended in the alignment system 100, one of ordinary skill in the art will appreciate that the cleaning jet 70a may, in some embodiments, be supported from below by the frame structure instead of suspended.

[0027] Figure 4 is a perspective view of the cleaning module 70, at which point the cleaning jet 70a has been inserted through the fixed cylinder 70b and into the storage tank 40 for the sludge removal operation. Once the alignment system 100 has been properly secured within the manhole adaptor 60, the cleaning jet 70a may be used to circulate and separate sludge that has accumulated within the storage tank 40. One or more alignment systems may be installed with the storage tank 40, as desired, such as depending on the size and shape of the storage tank, and/or the desired fluid circulation patterns within the storage tank 40. Examples and further description of a cleaning jet 70a or alignment system may be disclosed in co-pending Italian Patent Application No. MI2012A001150 (also published as International Publication WO 2014/001551), assigned to the assignee of the present disclosure, and hereby incorporated by reference in its entirety.

[0028] Referring now to Figure 5, an exploded view of an alignment system 100 in accordance with one or more embodiments of the present disclosure is shown. The alignment system 100 includes a frame structure having columns 102 that may be fastened together lengthwise by rails 104. In certain embodiments, the rails 104 may include generally cylindrical guide channels 111a on ends thereof that are configured to correspond with and slide over columns 102. The guide channels 111a may be integrally formed on ends of the rails 104 (*i.e.*, formed as an integral ring), or may be formed as split halves, and/or may be attached thereto. The guide channels 111a may slide over the columns 102 and be fastened in place with one or more mechanical fasteners. Alternatively, the rails 104 may be fastened to the columns 102 using fasteners, welds, or other known attachment methods once the rails 104 are positioned. While four columns 102 are shown, it should be understood that additional or fewer columns may be positioned along a length of the rails 104, such as for added support and rigidity, without

departing from the scope of the present disclosure. The vertical columns 102 may further include feet 106 that are attached to bottoms thereof and provide a more solid footing for the entire frame structure. The feet 106 may be substantially flat surfaces and may vary in area (*i.e.*, size) depending on the size of footprint desired. The feet 106 may be attached to the bottoms of columns 102 with mechanical fasteners, welds, or other known attachment methods.

[0029] In addition, the frame structure may further include one or more cross braces 108 that may be used to fasten columns 102 widthwise at least at one end of the frame structure, as shown. In certain embodiments, the cross braces 108 may be configured to have generally cylindrical guide channels 111b on either end which are configured to correspond with and slide over the columns 102. The guide channels 111b may be integrally formed on ends of the rails 104 (*i.e.*, formed as an integral ring), may be formed as split halves, and/or may be attached thereto. The guide channels 111b may slide over the columns and be fastened in place with one or more mechanical fasteners. Alternatively, those skilled in the art will appreciate additional attachment methods that may be used. For example, mechanical fasteners, welds, or other known attachment methods may be used to attach the cross braces 108 at the desired locations.

[0030] It should be understood that additional cross braces may be positioned along a length of the frame structure and attached to the rails 104. Further, the rails 104 and cross braces 108 may be positioned at various heights on the columns 102. In addition, expanded metal or other types of sheet metal may be attached to multiple columns or cross braces to provide further support.

[0031] The alignment system 100 may further include a support structure that includes separable upper module support 132 and lower module support 130. The support structure may be configured to support a cleaning module fixed cylinder 70b (Figure 4). The lower module support 130 may be attached to and between two columns 102 on one end of the frame structure as shown (and may serve as a cross brace similar to cross braces 108). The lower module support 130 may include a cradle 131 in which equipment, such as a fixed cylinder 70b (shown in Figure 4), may be positioned. The

cradle 131 of the lower module support 130 may be configured to correspond with an outer surface of the cleaning module fixed cylinder 70b. The cradle 131 of the lower support 130 is configured to reduce loading on the tank 40 (Figure 1) caused by the attachment of the fixed cylinder 70b to the tank 40. While the cradle 131 is shown as substantially semi-circular, it should be understood that other shapes may be used depending on an outer surface shape of the equipment to be supported and aligned (e.g., the fixed cylinder 70b), including, but not limited to, elliptical, square, or other polygonal shapes.

[0032] The upper module support 132 may be attached to the lower module support 130 using mechanical fasteners or other known attachment methods. Similar to the lower module support 130, the upper module support 132 may include an upper cradle surface 133 configured to correspond with an outer surface of the cleaning module fixed cylinder 70b. When the upper module support 132 and lower module support 130 are attached, the upper cradle surface 133 and lower cradle 131 form an opening that is configured to secure an end of the cleaning module fixed cylinder 70b in place during assembly and/or operation.

[0033] The alignment system 100 may further include a beam 120 disposed lengthwise from one end of the frame structure to the other. In certain embodiments, the beam 120 may be positioned near or at the top of the frame structure. In other embodiments, however, the beam 120 may be positioned lower or even near the bottom of the frame structure. At one end of the frame structure, the beam 120 may be fastened to a landing point 109a on the cross brace 108 and fastened thereto with mechanical fasteners, welds, or other known attachment methods. On the opposite end of the frame structure, the beam 120 may be fastened to a landing point 109b of the upper module support 132 with mechanical fasteners, welds, or other known attachment methods.

[0034] Landing points 109a and 109b may be configured to correspond with end surfaces of the guide beam 120 such that a secure connection of the guide beam 120 may be made to the landing points. For example, in certain embodiments, the landing points 109a and 109b may be substantially flat surfaces on which a bottom flange of the guide beam 120

engages. The substantially flat surfaces may have walls around a perimeter thereof configured to restrict the ends of the guide beam 120 from sliding off the substantially flat surface prior to being secured (*e.g.*, by mechanical fasteners, welds, or other known attachment methods). Those skilled in the art will appreciate alternative landing point configurations depending on the shape and structure of ends of the guide beam 120.

[0035] The beam 120 may be configured to serve as a guide track along which one or more roller mechanisms or trolleys 122, which are coupled thereto, are configured to traverse. For example, in certain embodiments, a cross section of the beam 120 may be an “I-beam” that is configured to have a vertical web and two horizontal flanges. In this example, the one or more trolleys 122 may be configured to traverse along a lower horizontal flange of the guide beam (*e.g.*, the trolley wheels are configured to roll along the flange surface), as will be understood by those skilled in the art. In addition, those skilled in the art will appreciate that other beam configurations may be used for beam 120, including, but not limited to, C-channel, T-beams, and other known beam configurations. The beam 120 may be a steel or other alloyed material as will be known to those skilled in the art. The trolleys 122 may include a number of smaller wheels or rollers configured to roll along a surface of the beam 120. One of ordinary skill in the art will appreciate that while a roller mechanism or trolley is referred to herein, embodiments of the present disclosure may also include a moveable device that is coupled to the beam or guide track and configured to traverse or move along the beam. For example, the moveable device may be coupled to the beam and configured to slide along the beam. Thus, the moveable device may include a surface configured to slidably engage a surface of the beam. For example, trolley 122 shown in Figure 5 may include one or more sliding surface instead of wheels or rollers, such that the sliding surface(s) are configured to engage a corresponding surface of the guide beam. In one embodiment, the beam 120 may include one or more wheels or rollers on which a sliding surface of the trolley 122 may slide across.

[0036] Further, adjustable linkages 124 may be attached to the trolleys 122 to provide a linkage from which to couple the cleaning jet 70a (shown in Figure 3) to the trolley. The adjustable linkages 124 may be attached to the trolleys 122 by hooks, loops, or other

hanging attachment methods known to those skilled in the art. For example, in certain embodiments, the adjustable linkages 124 may be adjustable fork tighteners. Lengths of the adjustable linkages 124 may be varied to manipulate a height of the cleaning jet 70a as it hangs from the guide beam 120 to align with the cleaning module fixed cylinder 70b, as will be described in further detail below. The lengths of the adjustable linkages 124 may be mechanically varied (*e.g.*, mechanical screw mechanism) in certain embodiments. In other embodiments, the lengths of the adjustable linkages 124 may be varied using hydraulic or electrical power. In certain embodiments, the lengths of the adjustable linkages 124 may be set to be substantially equal, which would align the suspended cleaning jet in a substantially horizontal setting. In other embodiments, the lengths of the adjustable linkages 124 may be different, for example, to provide an angled setting of the suspended cleaning jet 70a. Further, in certain embodiments, one or more lifting bands 126 may be attached to an end of the adjustable linkages 124. The lifting bands 126 may be wrapped around the cleaning jet 70a to hold the cleaning jet 70a in suspension.

[0037] In other embodiments, the cleaning module 70, and specifically the cleaning jet 70a, may be disposed above the beam 120. For example, the cleaning jet 70a may be supported by the beam 120 from below, rather than suspended from the beam 120. The cleaning jet 70a may be coupled to a trolley, roller mechanism, or other moveable device as described above, that is coupled to the beam to allow the cleaning jet 70a to be moved along the length of the beam in to and out of the body of the cleaning module and the tank.

[0038] The alignment system 100 may further include one or more winch devices 134. The winches 134 include cables 140 that may extend therefrom, a distal end of which may be attached the cleaning jet 70a (shown in Figure 6). Cables 140 are attached to the suspended cleaning jet 70a and operate to pull the suspended cleaning jet 70a toward the fixed cylinder 70b for insertion into the storage tank. The winch devices 134 may be attached to the fixed cylinder 70b (shown in Figure 6). Alternatively, the winch devices 134 may not be attached to the fixed cylinder 70b; instead, the winch devices 134 may be

secured in place to the frame structure. In certain embodiments, the winch devices 134 may be electric or pneumatic, and/or may have a braided cable extending therefrom.

[0039] In other embodiments, the winches 134 may be mechanical “come-along” devices that are manually operated, as will be understood by those skilled in the art. The come-along device may have a braided cable or chain that may extend therefrom and attach to the cleaning jet 70a. In alternate embodiments, the cables 140 may have hooks (not shown) on distal ends thereof that may be configured to temporarily attach to the cleaning jet 70a. The cables 140 may be any type of braided metal cable having any number of individually braided strands. In alternate embodiments, the cables 140 may be other materials including rope (*e.g.*, hemp, cotton, or nylon materials), twine, cord, line, string, chains, or other types known to those skilled in the art.

[0040] Referring now to Figures 6-9, multiple views of an alignment system 100 in which a cleaning jet 70a is suspended in accordance with one or more embodiments of the present disclosure are shown. Figure 6 provides a side view of the alignment system 100, Figure 7 provides a top view of the alignment system 100, Figure 8 provides one end view of the alignment system 100, and Figure 9 provides another end view of the alignment system 100.

[0041] Initially, the alignment system 100 may be assembled and coupled with a first end of the fixed cylinder 70b. As previously described, the fixed cylinder 70b may be configured to be secured between an upper cleaning module support 132 and a lower cleaning module support 130. A second end of the fixed cylinder 70b is attached to the manhole adaptor 60 (Figure 4). Thus, the cleaning module fixed cylinder 70b may be secured on both ends prior to insertion of the cleaning jet 70a.

[0042] Next, the cleaning jet 70a may be fastened to and suspended within the alignment system 100. For example, the adjustable linkages 124 may be configured to extend downward to the floor or a height at which the cleaning jet 70a is resting to attach to the cleaning jet 70a. The cleaning jet 70a may be attached to adjustable linkages 124, which are suspended from trolleys 122, at attachment points on the cleaning jet 70a. The attachment points may be located anywhere along the axial length of the cleaning jet 70a,

as required and understood by those skilled in the art. Further, in certain embodiments, one or more lifting straps 126 may be used at one or more attachment points on the cleaning jet 70a. Those skilled in the art will understand that one or more lifting straps 126 may be used along an axial length of the cleaning jet 70a.

[0043] The adjustable linkages 124 may be lengthened or shortened (either manually or powered) to align the cleaning jet 70a at a particular height and angle with the fixed cylinder 70b prior to insertion. More precisely stated, the alignment system 100 is configured to substantially axially align a central axis of the cleaning jet 70a with a central axis of the fixed cylinder 70b bore prior to insertion. In certain embodiments, the adjustable linkages 124 may be adjusted to about the same lengths, such that the cleaning jet 70a is substantially horizontal (*i.e.*, level) in a suspended state. In other embodiments, the adjustable linkages 124 may be adjusted to different lengths to effectuate a particular angle at which the cleaning jet 70a is suspended in the alignment system 100. In certain embodiments, the angle (in relation to substantially horizontal) at which the suspended cleaning jet 70a hangs may be between about 1 degree and about 30 degrees. In other embodiments, the angle (in relation to substantially horizontal) at which the suspended cleaning jet 70a hangs may be between about 5 degrees and about 15 degrees. Those skilled in the art will appreciate that other angled configurations are also within the scope of one or more embodiments of the present disclosure.

[0044] Once proper alignment of the cleaning jet 70a with the fixed cylinder 70b is accomplished, cables 140 of winch devices 134 may be extended axially from the winch devices 134 and attached to the cleaning jet 70a. Next, the winch devices 134 may be used and/or activated to apply a force (in the direction of arrow F) to the cleaning jet 70a. The winch devices 134 will take in the cables 140 (*i.e.*, wrap the cables around an inner spool or otherwise), thereby causing the trolleys 122 to roll on the beam 120 and move the suspended cleaning jet 70a toward the fixed cylinder 70b. The cleaning jet 70a may be inserted into the fixed cylinder 70b until an end surface 71 of the cleaning jet 70a engages a face 72 of the fixed cylinder 70b, at which point the winch devices 134 are turned off. The cleaning module 70a may be fastened to the fixed cylinder 70b by one or more mechanical fasteners (*e.g.*, a bolt circle of end surface 71). In certain embodiments,

a gasket or other sealing material may be between the end surface 71 of the cleaning jet 70a and the face 72 of the fixed cylinder 70b to prevent leakage. During the sludge removal process, the cleaning jet 70a may remain fastened to the fixed cylinder 70b. Once the sludge removal process is complete, the suspended cleaning module 70a may be unfastened from the fixed cylinder 70b and removed from the storage tank 40, such as in a reverse process similar to that described above when aligning and disposing the cleaning jet 70a within the fixed cylinder 70b.

[0045] Embodiments of the present disclosure may provide an alignment system capable of providing faster alignment of a cleaning jet for insertion into a storage tank. Properly aligning the cleaning jet may take less time, which may allow more efficient and faster cleaning of storage tanks. Because the storage tanks may be cleaned faster, the storage tanks may also be returned to service sooner allowing operations to run uninterrupted for longer periods of time. In addition, less manual input for manipulation of the cleaning jet by personnel may be used in the alignment system described in accordance with one or more embodiments of the present disclosure. As such, the alignment system may reduce a risk of injury to personnel involved with storage tank sludge removal. Still further, the alignment system described in accordance with embodiments herein may prevent leaks during the sludge removal method because of the precise alignment of the cleaning jet with the fixed cylinder. Therefore, the interface between the cleaning jet and fixed cylinder may have generally even circumferential contact, thereby mitigating leakage. Leakage reduction or prevention may further provide beneficial environmental effects by preventing harmful fluids and sludge from coming into contact with the environment.

[0046] While the present disclosure has been described with respect to a limited number of embodiments, those skilled in the art, having benefit of this disclosure, will appreciate that other embodiments may be devised which do not depart from the scope of the disclosure as described herein. Accordingly, the scope of the disclosure should be limited only by the attached claims.

CLAIMS

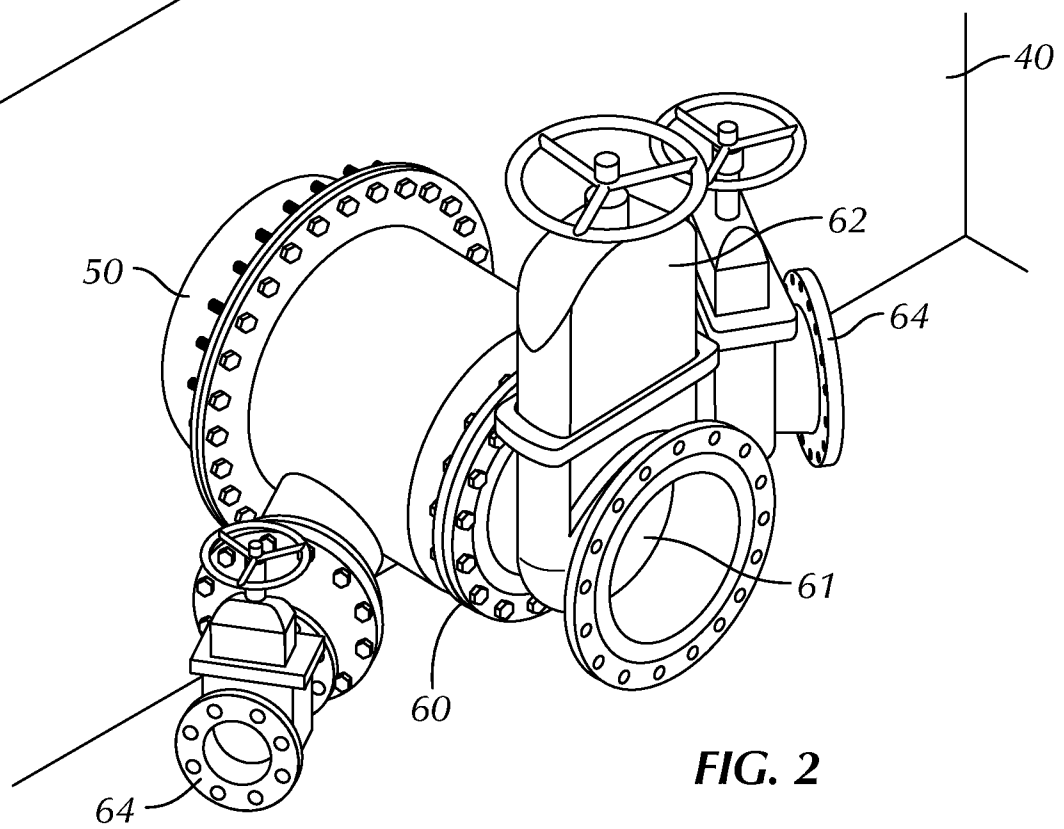
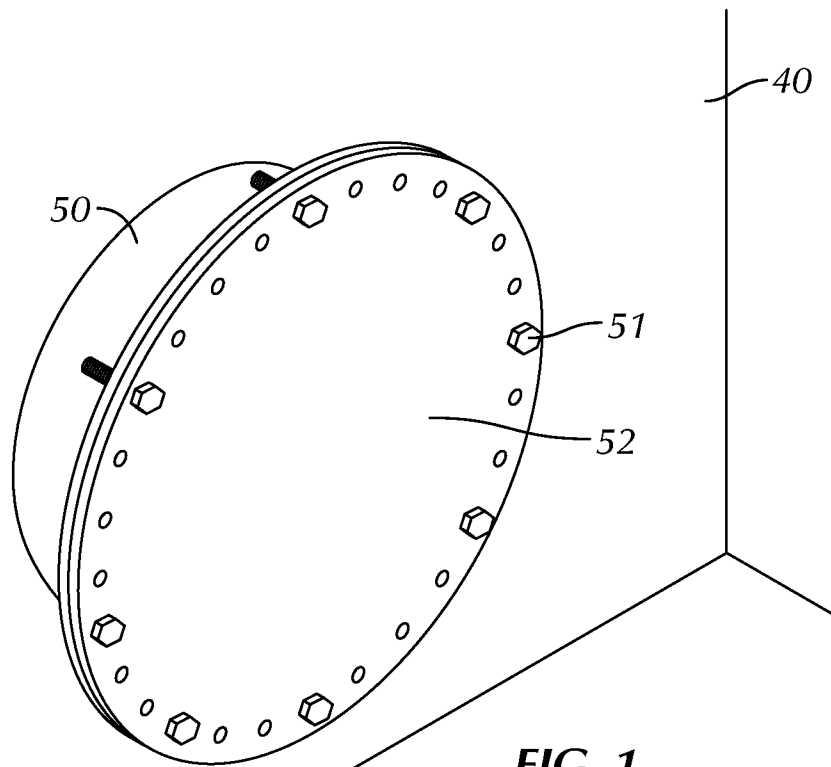
What is claimed is:

1. An apparatus comprising:
 - a frame structure having a guide beam;
 - a moveable device coupled to the guide beam;
 - a support structure coupled to the frame structure and configured to engage a body of a cleaning module; and
 - a cleaning jet coupled to the moveable device and configured to move along the guide beam into the body of the cleaning module.
2. The apparatus of claim 1, further comprising:
 - an adjustable linkage fastened between the moveable device and the cleaning jet.
3. The apparatus of claim 2, further comprising a second adjustable linkage fastened between the moveable device and the cleaning jet, wherein the adjustable linkage and the second adjustable linkage are independently adjustable.
4. The apparatus of claim 1, wherein the moveable device includes at least one roller engaged with the guide beam.
5. The apparatus of claim 1, wherein the moveable device includes a first roller mechanism and a second roller mechanism, wherein a first end of the cleaning jet is suspended from the first roller mechanism and a second end of the cleaning jet is suspended from the second roller mechanism.
6. The apparatus of claim 1, wherein a first end of the body of the cleaning module is coupled to a manhole adaptor attached to a storage tank.
7. The apparatus of claim 1, wherein the support structure comprises an upper module support and a lower module support.

8. The apparatus of claim 1, wherein the moveable device includes a sliding surface engaged with a corresponding sliding surface of the guide beam.
9. The apparatus of claim 1, further comprising:
 - a winch device coupled to the frame structure; and
 - a cable extending from the winch device and attached to the cleaning jet.
10. The apparatus of claim 1, wherein a central axis of the cleaning jet is aligned with a central axis of the body of the cleaning module.
11. A method comprising:
 - coupling a cleaning module to a frame structure, the cleaning module having a body and a cleaning jet, the coupling including:
 - moveably coupling the cleaning jet to a guide beam, the guide beam supported by the frame structure; and
 - securing the body with a support structure of the frame structure; and
 - coupling the body of the cleaning module to a tank.
12. The method of claim 11, further comprising moving the cleaning jet along the guide beam into the body of the cleaning module and into the tank.
13. The method of claim 11, further comprising:
 - using a winch device coupled between the cleaning jet and one of the body of the cleaning module and the frame structure to move the cleaning jet along the guide beam toward the tank.
14. The method of claim 11, further comprising:
 - aligning the cleaning jet with the body of the cleaning module by adjusting a suspended height of at least one end of the cleaning jet.
15. The method of claim 11, further comprising cold tapping the tank to provide an access to inside the tank.

16. The method of claim 15, wherein the coupling the body of the cleaning module to the tank comprises attaching the body of the cleaning module to the tank over the access.
17. A system, comprising:
a tank;
a module removably coupled to the tank, the module including a body and a cleaning jet;
and
a frame structure having a guide beam and a trolley moveably coupled to the guide beam,
the cleaning jet coupled to the trolley.
18. The system of claim 17, further comprising a support structure coupled to the frame structure and configured to receive the body of the module.
19. The system of claim 17, further comprising a winch device having a cable extending therefrom, the cable coupled to the cleaning jet.
20. The system of claim 17, wherein a central axis of the cleaning jet is aligned with a manway of the tank.

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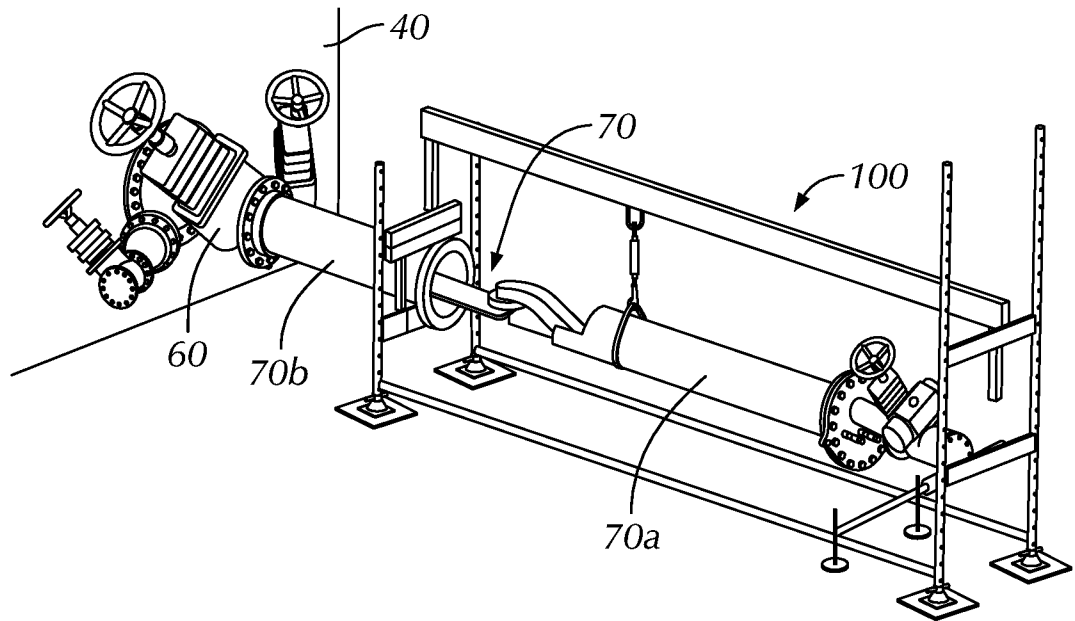


FIG. 3

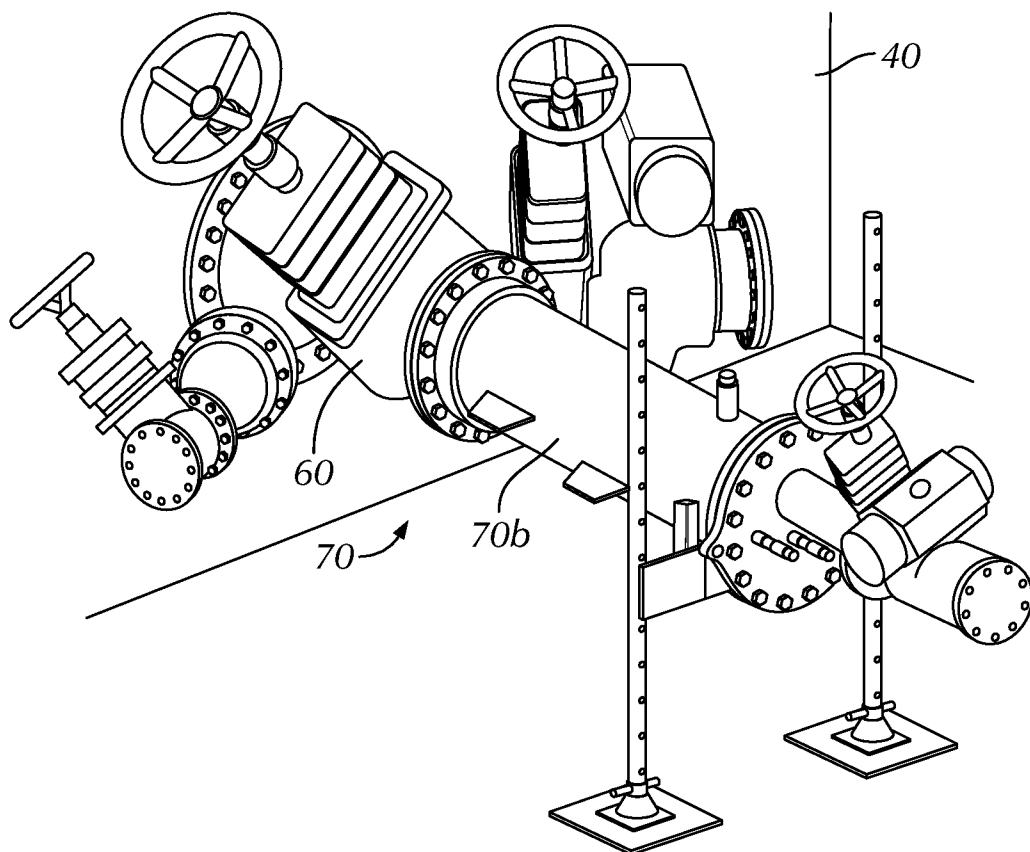


FIG. 4

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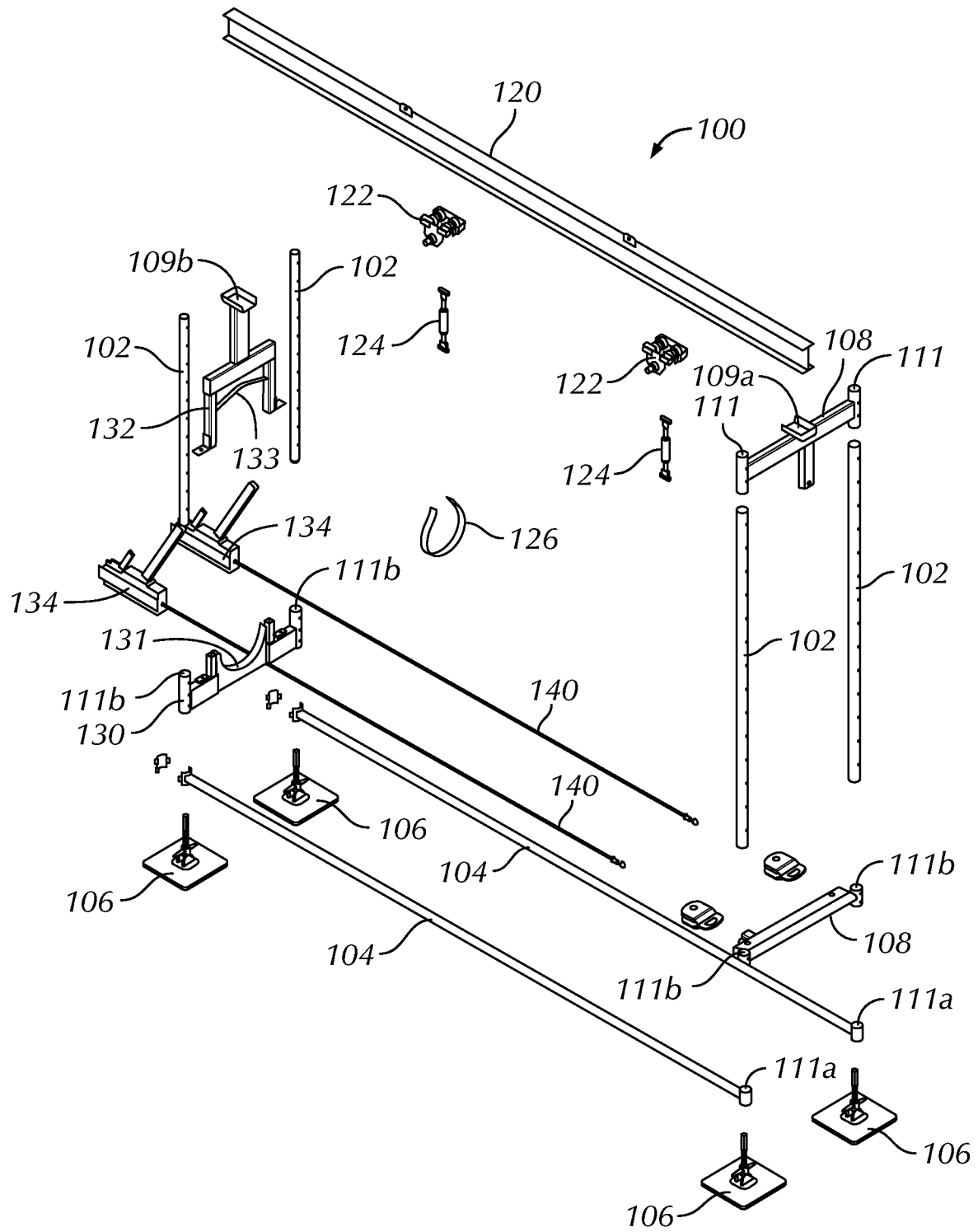


FIG. 5

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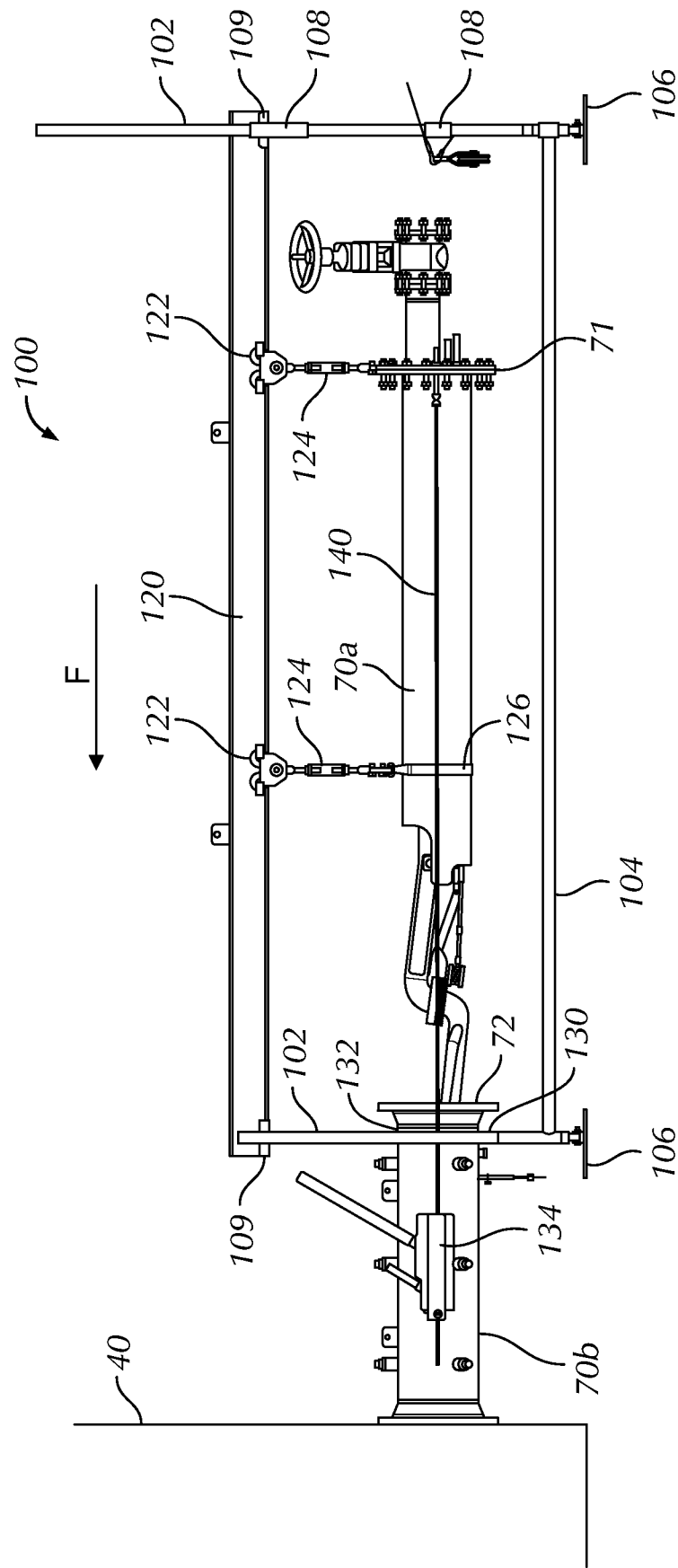
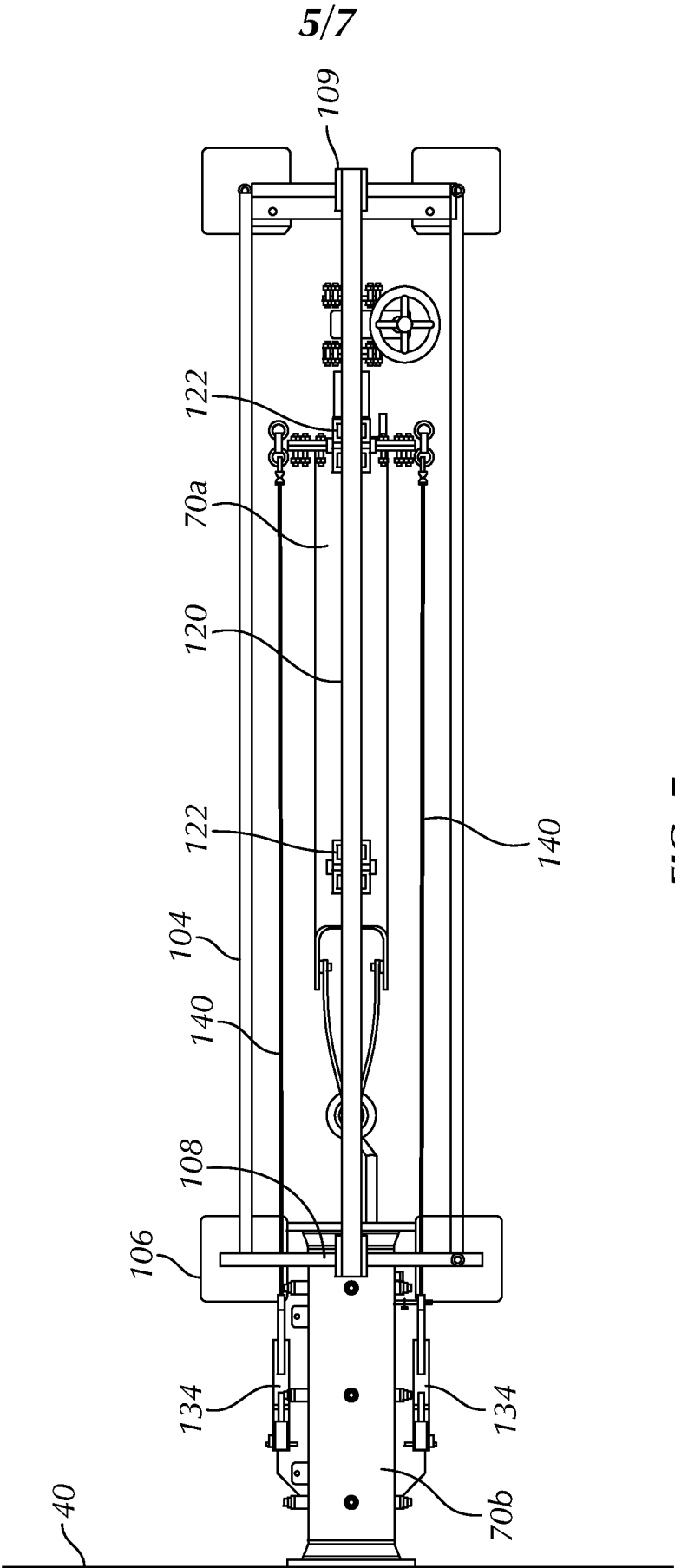


FIG. 6



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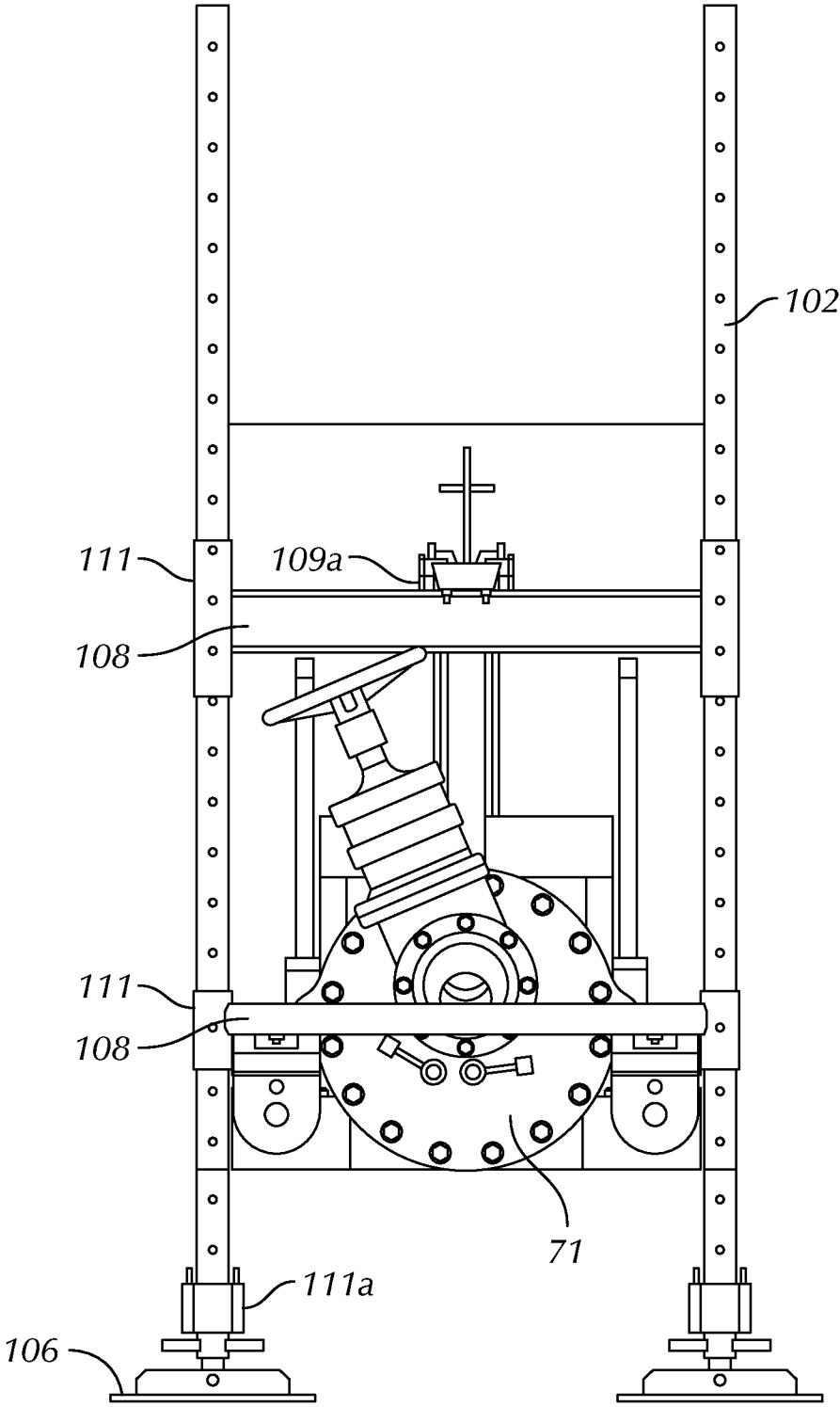


FIG. 8

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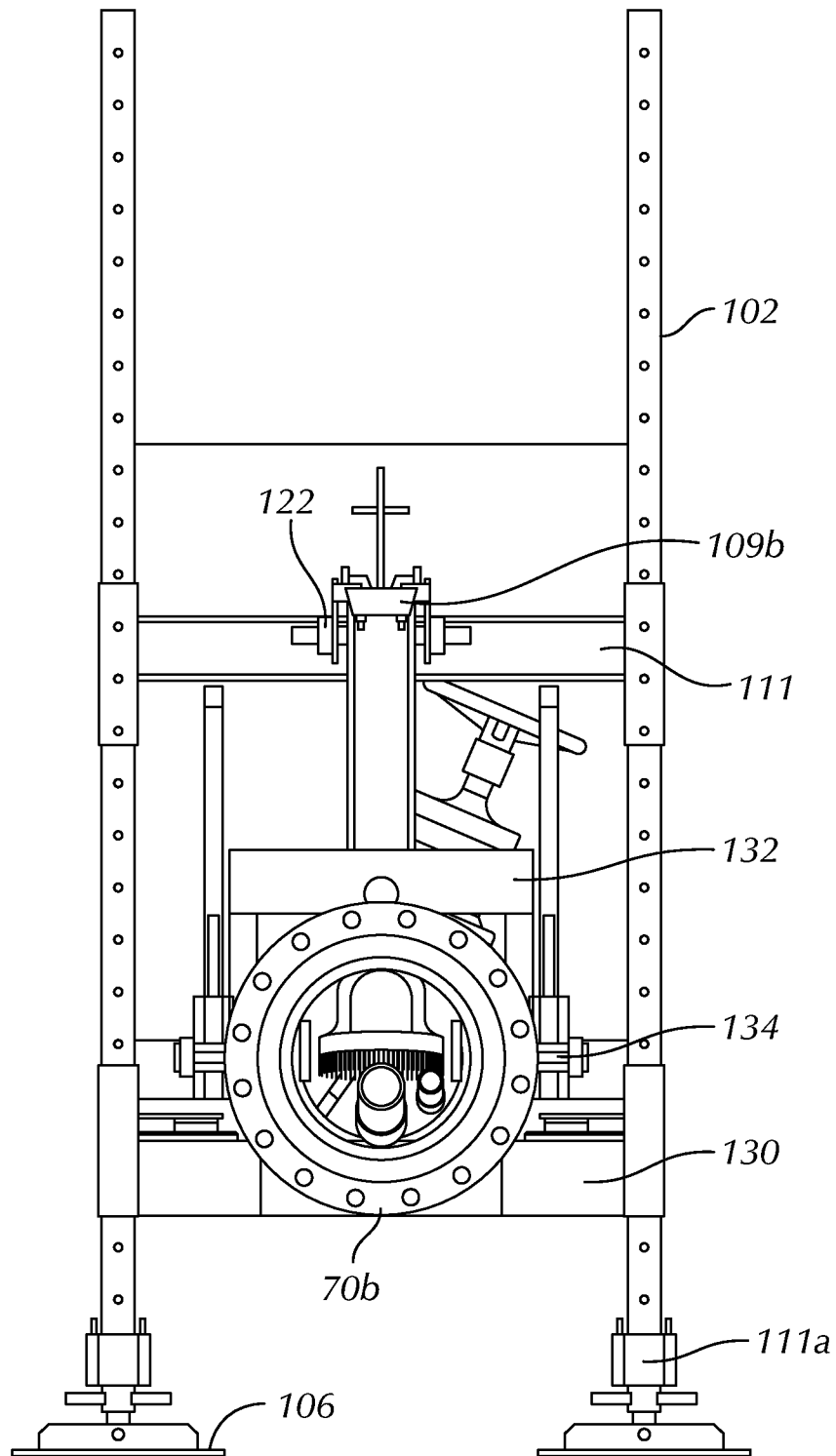


FIG. 9

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2014/027169**A. CLASSIFICATION OF SUBJECT MATTER****B08B 9/08(2006.01)i, B08B 9/093(2006.01)i**

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

B08B 9/08; B08B 9/02; B08B 9/00; B08B 3/12; B08B 3/02; B08B 9/093

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

Korean utility models and applications for utility models

Japanese utility models and applications for utility models

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

eKOMPASS(KIPO internal) & Keywords: tank, cleaning, wash, frame, support, trolley, roller and slide

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5474097 A (LOWE et al.) 12 December 1995 See abstract; column 3, lines 17-26,47-65; and figures 1,3.	1-5,7,8,10,17,18 ,20
Y		6,9,11-16,19
Y	US 4574825 A (HAUG, JOSEF) 11 March 1986 See abstract; column 2, lines 67-68; claim 1; and figures 1,2.	6,11-16
Y	US 2011-0197936 A1 (LORENTZ-LARSEN et al.) 18 August 2011 See abstract; paragraph [0013]; claim 1; and figures 1,2.	9,13,19
A	CN 102658275 A (JIANGSU WUJIN STAINLESS CO., LTD.) 12 September 2012 See abstract; paragraph [0013]; and figures 1,2.	1-20
A	US 2005-0199269 A1 (HEIL et al.) 15 September 2005 See abstract; paragraph [0027]; claim 1; and figure 1.	1-20



Further documents are listed in the continuation of Box C.



See patent family annex.

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Date of the actual completion of the international search

02 July 2014 (02.07.2014)

Date of mailing of the international search report

04 July 2014 (04.07.2014)

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/US2014/027169

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