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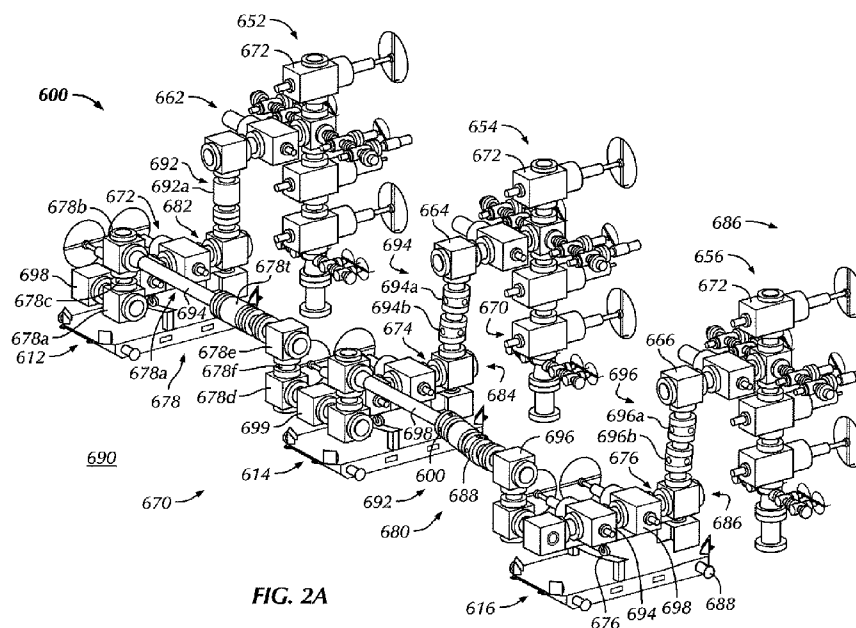


FIG. 2A

(57) Abstract: A frac transfer system (600) may include a Christmas tree (652) having a lateral extension (662); and a manifold (670) in fluid communication with the Christmas tree. A portion of the manifold may be positioned at least partially under the lateral extension of the tree and disposed on an adjustable skid (612) that facilitates connection between the portion of the manifold and the lateral extension of the tree.



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FRAC TRANSFER SYSTEM

BACKGROUND

[0001] Fracture systems are used to inject fracture fluids into wellbore systems. The fracture fluids may create fractures in a portion of the substrate surrounding the wellbore system, such that the substrate releases hydrocarbons and the hydrocarbons may be recovered via the wellbore system. A fracture system may include one or more Christmas trees and one or more manifolds. A fracture system may include additional surface and subsurface components. Each of the Christmas trees may be connected to a manifold.

[0002] FIG. 1 illustrates a fracture system 20 in which connections are made between Christmas trees 12 and manifold 14 using flowline paths 52. The flowline paths 52 may each be composed of one or more piping components, which may include straight segments 54 and angled segments 56. The piping components may be connected to each other using swivel joints 58. Typically, the manifold 14 is assembled and then connected to the trees 12 using the flowline paths 52. The segments 54, 56 and the swivel joints 58 collectively provide adjustability in the flowline paths 52 that facilitate connections between manifold 14, which is not necessarily in strict alignment with the trees 12, and the trees 12. As depicted, more than one flowline path 52 may be connected between each Christmas tree 12 and the manifold 14 to provide the necessary flow volume for a fracturing operation. These multiple connections may occupy a significant amount of space in the fracture system 20, and may require a significant amount of time and personnel to assemble, test, and disassemble.

SUMMARY OF THE DISCLOSURE

[0003] Embodiments disclosed herein relate to devices, systems, and methods for forming and aligning large bore connections in fracture systems.

[0004] This summary is provided to introduce a selection of concepts that are further described below in the detailed description. This summary is not intended to identify key or essential features of the claimed subject matter, nor is it intended to be used as an aid in limiting the scope of the claimed subject matter.

[0005] In one aspect, the present disclosure relates to a frac transfer system which may include a Christmas tree having a lateral extension; and a manifold in fluid communication with the Christmas tree. A portion of the manifold may be positioned at least partially under the lateral extension of the tree and disposed on an adjustable skid that facilitates connection between the portion of the manifold and the lateral extension of the tree.

[0006] The adjustable skid of the frac transfer system may include: a base platform; one or more supports disposed on the base platform; and one or more adjusters disposed on the supports, wherein the adjusters are configured to provide relative movement between the portion of the manifold and the base platform.

[0007] The adjusters of the frac transfer system may include a pivot joint and one or more wheels that are configured to engage with and travel along a track coupled to the supports.

[0008] The adjustable skid of the frac transfer system may include one or more secondary adjusters coupled to the base platform and configured to alter the relative position between the base platform and the ground when the adjustable skid is deployed.

[0009] The frac transfer system may include a flowline coupled between the portion of the manifold and the lateral extension of the Christmas tree, wherein the flowline includes a swivel joint.

[0010] The unit flowline of the frac transfer system may include at least one of a spacer and a wedge joint.

[0011] In another aspect, the present disclosure relates to a frac transfer system including a second Christmas tree, wherein a second portion of the manifold is disposed on a second adjustable skid that facilitates connection between the second portion of the manifold and the second Christmas tree and between the first portion of the manifold and the second portion of the manifold.

[0012] The frac transfer system may include a manifold flowline connecting the portion of the manifold to the second portion of the manifold, wherein the manifold flowline comprises a plurality of pipe spools.

- [0013] The manifold flowline of the frac transfer system may include at least one of a spacer and a wedge joint.
- [0014] The manifold flowline of the frac transfer system may include at least two elbow blocks and a swivel joint positioned therebetween.
- [0015] In another aspect, the present disclosure relates to a method which may include the following steps: positioning a first portion of a manifold under a lateral extension of a first Christmas tree and altering an orientation of the first portion of the manifold with respect to the lateral extension. The first portion of the manifold may be disposed on a first adjustable skid. The orientation of the first portion of the manifold may be altered with respect to the lateral extension using the adjustable skid. The adjustable skid may facilitate a fluid connection between the first portion and the manifold of the first Christmas tree.
- [0016] The method may also include the following step: after the first portion of the manifold is connected to the first Christmas tree, altering an orientation of the first portion of the manifold with respect to the adjustable skid to facilitate connection between the first portion of the manifold and the second portion of the manifold.
- [0017] The method may also include altering the orientation of the first portion of the manifold with respect to the lateral extension using, at least in part, the adjustable skid comprises raising or lowering the first portion of the manifold with respect to the lateral extension.
- [0018] The method may also include raising or lowering the first portion of the manifold with respect to the lateral extension comprises operating at least one jack coupled to the adjustable skid to raise or lower the adjustable skid.
- [0019] The method may also include the following steps: positioning a second portion of a manifold under a lateral extension of a second Christmas tree, wherein the second portion of the manifold is disposed on a first adjustable skid; altering an orientation of the second portion of the manifold with respect to the lateral extension using, at least in part, the second adjustable skid of the second Christmas tree; establishing a fluid connection between the second portion of the manifold and the second Christmas tree; after the second portion of the manifold is connected to the

second Christmas tree, altering an orientation of the second portion of the manifold with respect to the second adjustable skid to facilitate connection with the first portion of the manifold.

[0020] The method may also include the following step: connecting the first portion of the manifold to the lateral extension of the first Christmas tree using at least one or a spacer and a wedge joint.

[0021] In another aspect, the present disclosure relates to a spacer which may include a body having a first end and a second end and a bore extending therethrough. The body may have an outer surface. The first end and the second end may be configured to form metal-to-metal seals. The first end and the second end may be disposed at an angle greater than zero degrees to each other.

[0022] The first end and the second end of the spacer may each include a depressed region proximate the outer surface, a raised region medial to the depressed region, and a trough proximate the bore.

[0023] The spacer may include a connector formed therethrough.

[0024] The bore of the spacer may include one or more linear segments.

[0025] The bore of the spacer may be normal to both the first end and to the second end.

[0026] In some embodiments of the spacer, an angle formed between the first end and the second end is between five degrees and ten degrees.

[0027] The spacer may include a reinforced wall disposed around the bore.

[0028] In another aspect, the present disclosure relates to a frac transfer unit which may include a Christmas tree, a portion of a manifold, a unit flowline connected between the Christmas tree and the portion of the manifold. The unit flowline may include at least one spacer. The spacer may include a body having a first end and a second end and a bore extending therethrough. The body may have an outer surface. The first end and the second end may be configured to form metal-to-metal seals. The first end and the second end may be disposed at an angle greater than zero degrees to each other.

- [0029] The unit flowline of the frac transfer unit may be substantially vertical.
- [0030] In some embodiments of the frac transfer unit, a portion of the manifold may be disposed on an adjustable skid and at least partially positioned under a lateral extension of the Christmas tree.
- [0031] In some embodiments of the frac transfer unit, the frac inlet of the Christmas tree may be offset from an inlet of the portion of the manifold.
- [0032] The frac transfer unit may include a unit flowline which comprises more than one spacer, such that the unit flowline is non-linear in more than one direction.
- [0033] In another aspect, the present disclosure relates to a frac transfer system including: two or more frac transfer units according to any embodiment disclosed herein; and a manifold flowline connected between the portion of the manifold of a first of the frac transfer units and the portion of the manifold of a second of the frac transfer units, the manifold flowline comprising at least one spacer. The spacer may include: a body having a first end and a second end; and a bore extending therethrough. The body may have an outer surface; the first end and the second end may be configured to form metal-to-metal seals; and the first end and the second end may be disposed at an angle greater than zero degrees to each other.
- [0034] The manifold flowline of the frac transfer system may be substantially horizontal.
- [0035] In some embodiments of the frac transfer system, an inlet of the manifold of the first frac transfer unit may be offset from an inlet of the manifold of the second frac transfer unit.
- [0036] The manifold flowline of the frac transfer system may include at least one wedge spacer.
- [0037] The manifold of the frac transfer system may be a time and efficiency manifold or a zipper manifold.
- [0038] In some embodiments, the frac transfer system may include a manifold flowline which comprises more than one spacer, such that the unit flowline is non-linear in more than one direction.

[0039] In another aspect, the present disclosure relates to a method which may include the following steps: assembling a unit flowline, the assembling comprising connecting a piping component to a wedge spacer and connecting a Christmas tree to a manifold, via the unit flowline.

[0040] The method may also include the following step: injecting a fracture fluid through the frac transfer system.

[0041] Other aspects and advantages will be apparent from the following description and the appended claims.

BRIEF DESCRIPTION OF DRAWINGS

[0042] FIG. 1 is a fracture system in accordance with the prior art.

[0043] FIG. 2a is a perspective view of a fracture system in accordance with embodiments of the present disclosure.

[0044] FIG. 2b is a top view of a fracture system in accordance with embodiments of the present disclosure.

[0045] FIG. 2c is a side view of a fracture system in accordance with embodiments of the present disclosure.

[0046] FIG. 3a is a spacer in accordance with embodiments of the present disclosure.

[0047] FIG. 3b is a spacer in accordance with embodiments of the present disclosure.

[0048] FIG. 4a is a spacer in accordance with embodiments of the present disclosure.

[0049] FIG. 4b is a spacer in accordance with embodiments of the present disclosure.

[0050] FIG. 5a is a cross-section view of a wedge spacer in accordance with embodiments of the present disclosure.

[0051] FIG. 5b is a perspective view of a wedge spacer in accordance with embodiments of the present disclosure.

[0052] FIG. 5c is a perspective view of a wedge spacer in accordance with embodiments of the present disclosure.

[0053] FIG. 6a is a perspective view of an adjustable skid in accordance with embodiments of the present disclosure.

[0054] FIG. 6b is a side view of an adjustable skid in accordance with the present disclosure.

[0055] FIG. 6c is a top view of an adjustable skid in accordance with embodiments of the present disclosure.

DETAILED DESCRIPTION

[0056] Embodiments of the present disclosure will now be described in detail with reference to the accompanying Figures. Like elements in the various figures may be denoted by like reference numerals for consistency. Further, in the following detailed description of embodiments of the present disclosure, numerous specific details are set forth in order to provide a more thorough understanding of the claimed subject matter. However, it will be apparent to one of ordinary skill in the art that the embodiments disclosed herein may be practiced without these specific details. In other instances, well-known features have not been described in detail to avoid unnecessarily complicating the description. Additionally, it will be apparent to one of ordinary skill in the art that the scale of the elements presented in the accompanying Figures may vary without departing from the scope of the present disclosure.

[0057] As used herein, the term “coupled” or “coupled to” or “connected” or “connected to” may indicate establishing either a direct or indirect connection, and is not limited to either unless expressly referenced as such.

[0058] Embodiments of the present disclosure relate to devices, systems, and methods for forming and aligning large bore connections in fracture systems. The present disclosure may enable components of a fracture system to be connected using large bore flowlines and allow the connections to be made precisely, such that strong metal-to-metal seals may be formed between adjacent components. The present disclosure may further enable connecting flowlines to be substantially linear, and thereby occupy a small profile and apply reduced weight to system components.

[0059] Embodiments of the present disclosure include: an adjustable skid on which manifold portions may be disposed; spacers, including wedge spacers; fracture systems including the skids and/or spacers; and a method of manufacturing and using a fracture system including the skids and/or spacers. Systems disclosed herein may utilize spacers and adjustable skids to create parallel and perpendicular connections for large straight joints. A fracture system may provide a single flow path to each well while isolation to other wells may be provided by valves. Such a system may have a reduced profile compared to a fracture system such as those shown in FIG. 1, may be easier to assemble and operate. Such a system may further require fewer connections, create a more streamlined profile, and take up a smaller footprint.

[0060] In one aspect, embodiments of the present disclosure relate to an adjustable skid which may be used in a fracture system and which may adjust a position and orientation of one or more manifold portions disposed on the skid to facilitate connection between the manifold and the trees.

[0061] FIGs. 2a-2c illustrates fracture system 600 incorporating aspects of the present disclosure. The system 600 includes a plurality of Christmas trees 652-656 which may be any type of tree known in the art. Each of the Christmas trees 652-656 may have respective lateral extensions 662-666 that extend in a lateral direction from the vertical axes of the trees 652-656. As depicted, the lateral extensions 662-666 each comprise a valve connected to the tree and a block tee coupled with the valve, with one opening of the block tee pointed toward the ground 690 in a substantially vertical direction. It should be appreciated that the trees 652-656 and the lateral extensions 662-666 are not limited to the forms depicted, nor do the trees 652-656 and lateral extensions 662-666 need to be identical within a given system.

[0062] The system 600 further comprises a manifold 670, which may comprise a plurality of manifold portions that are fluidly connected to form a manifold through which fracturing fluid can be provided to the Christmas trees 652-656 from a fracturing fluid source. As depicted, the manifold portions include, but are not limited to, valve assemblies 672-676; manifold flowlines 678, 680, which respectively connect valve assembly 672 to valve assembly 674 and valve assembly

674 to valve assembly 676; and other connectors, spools, joint, etc. The manifold 670 may terminate at one or more connectors 682-686, through which the manifold 670 may be connected to the trees 652-656, with each connector 682-686 dedicated to a different tree. In the embodiment depicted, the connectors 682-686 each comprise a block tee and a swivel joint that is pointed upwards in a substantially vertical direction. Other configurations of connectors 682-686 are possible within the scope of this disclosure, including, but not limited to, a connector that just includes the block tee, with the swivel joint being incorporated into a unit flowline 692 between the block tee and the lateral extension 662.

[0063] The manifold 670 may be in fluid communication with the Christmas trees 652-656 to selectively supply fracturing fluid from a fracturing fluid source (not shown) to the Christmas trees 652-656. As depicted, the manifold 670 is fluidly connected to each of the Christmas trees 652-656 through unit flowlines 692-696 that are respectively connected between lateral extensions 662-666 and manifold connectors 682-686. In certain embodiments, a portion of the manifold 670, in this case the connectors 682-686, may be at least partially positioned under a lateral extension 662-666 of at least one of the trees 652-656. This positioning may reduce the overall footprint of the system 6600, may result in less equipment on the ground, and may be primary performed by a crane or other heavy lifting equipment when the manifold portions are deployed to the frac site, as will be described in detail below.

[0064] One or more portions of the manifold 670 may be disposed on adjustable skids 612-616 that provide for relative movement between the one or more portions of the manifold and the skid to facilitate alignment between the manifold portions and the trees 652-656, and between the manifold portions themselves. That is, once the skids are set in place by heavy lifting equipment, the manifold portion may move with respect to the skid base to align the manifold portion with the tree to which it will be connected. In the embodiment shown, the manifold portions comprise at least valve assemblies 672-676 and connectors 682-686, with each adjustable skid 612-616 including one valve assembly/connector set. The arrangement of the manifold portions on the skids are not limited to the embodiments shown here, as it may be possible to include more or less manifold portions, or different combinations of manifold portions on a particular skid.

[0065] An adjustable skid 612 may include a base platform 603 and one or more adjusters 607a-607b. The base platform 603 may be a fixed structure, such that once the base platform is disposed on a substrate 690 using external equipment (not shown), the base platform 603 is largely immobile. In some embodiments, the skid 612 may include lift points 611 which may allow for some movement of the base platform 603. The skid 612 may further include fork lift slots 609 as a secondary means to move the base platform relative to the substrate 690. Adjustable skids 614 and 616 may, but are not required to, have similar configurations.

[0066] In some embodiments, supports 605a-605b may be disposed on the base platform 603. In some embodiments, as shown in FIGs. 2a-2c, each support 605a-605b may comprise metal extensions from the base platform 603 that engages with the adjusters 607a-607b, but a support 605a-605b may have alternative structures that may provide similar functionality. In some embodiments, as shown in FIGs. 2a-2c, a skid 612 may include two supports 605a-605b and the supports 605a-605b may have different dimensions than each other. In some embodiments, a skid 612 may include any number of supports 605a-605b. The adjusters 607a-607d may be disposed on the supports 605a-605b. In certain embodiments, the supports 605a-605b may be excluded, with any functionality provided thereby incorporated into the base platform 603.

[0067] The adjusters 607a-607b may provide relative movement between the base platform 603 and the manifold portion 672/682 disposed on the skid 612. For instance, the adjusters 607a-607b may allow for the manifold portion 672/682 to be moved in x/y/z dimensions with respect to the base platform and/or for the manifold portion to be pivoted, rotated, twisted, or moved in any other orientation/direction relative to the base platform 603. For example, adjusters 607a-607b may be linear positioners which can be configured to have a range of lengths, but adjusters may also be other structures. The adjusters 607a-607b may operate via any mechanism, for example, via a hydraulic or mechanical mechanism. The adjusters 607a-607b may be able to be locked at any of the range of lengths. The length of each of the adjusters 607a-607b may be controlled via any means, including through manual adjustment or control by a wireless or wired control system (not shown). A control system may independently command the adjusters 607a-607b or may command one

or more adjusters 607a-607b together. In some embodiments, the adjusters 607a-607b may be disposed between the base platform 603 and the supports 605a-605b, rather than on top of the supports 605a-605b.

[0068] In the embodiment shown, adjuster 607a is a ball joint coupled to a bottom surface of connector 682 that engages a socket coupled to the support 605a, and adjuster 607b comprises wheels that engage with and travel on a track of the support 605b. This arrangement may facilitate a pivoting movement of the manifold portion 672/682 with respect to the base 603, with a longitudinal axis of the manifold portion 672/682 rotating about the adjuster 607a.

[0069] FIGs. 6a-6c illustrate another example adjustable skid 812 with similar elements as skid 612, including base 803 and adjusters 807a-807b. Notably, the adjustable skid 812 differs from adjustable skid 612 at least in that the shape of the base platform 803 has been altered to provide a larger pivot range for the manifold portion 872, e.g., up to thirty degrees, and the functionality provided by the supports 605a-605b in skid 612 has been largely incorporated into the base 803 of skid 812. Additionally, adjustable skid 812 further comprises one or more adjusters 809a-809d coupled to the base platform 803 that allow the position of the base platform 803 to be altered with respect to the substrate. These adjusters 809a-809d may comprise, for instance, independently controllable jacks that allow each corner of the base platform to be independently raised/lowered with respect to the substrate. These adjusters 809a-809d may at least provide height adjustment for the manifold portion 872 disposed on the adjustable skid 812 as well as control of the planar orientation of the manifold portion 872 with respect to the ground.

[0070] In some embodiments, an adjustable skid (not shown) may include a secondary platform that is movably coupled to the base platform by one or more adjusters and on which manifold portions such as valve assemblies may be fixedly disposed. The secondary platform may be connected to the base platform such that the position and orientation of the secondary platform and therefore the manifold portion with respect to the base platform may be modified by the adjusters, which may comprise hydraulic, pneumatic, or electric actuators, for instance. In some embodiments, any mechanism capable of movement in one or more dimensions may

be disposed between the base platform and the secondary platform. In some embodiments, the mechanism may be capable of movement in up to three spatial dimensions and three angular dimensions, such that the position and orientation of the moving platform and equipment disposed thereon may be fully controlled.

[0071] Returning to FIGs. 2a-2c, configuring the adjusters 607a-607b may adjust the orientation and position of the manifold portion 672/682 and, to an extent, associated piping with respect to the tree 652 and the other manifold portions 674/684 and 676/686 to facilitate connections that do not rely on multi-segmented pipe and swivel arrangements that are typically used. For instance, the connector 682 may be positioned under the lateral extension 662 of the tree 662 by the adjustable skid 612 to enable a substantially vertical, direct connection. Such alignment may allow the connectors to form metal-to-metal seals with the other components. The adjustable skid 612 may raise/lower, swivel/rotate, and/or tilt the valve assemblies 672. The adjustable skid 612 may be capable of positioning the valve assemblies 672 in up to three spatial dimensions and positioning the valve assemblies 672 at a desired angle.

[0072] Once the connector 682 is attached to the tree 651 via flowline 692, the valve assembly 672 may be pivoted about the adjuster 607a to position a tee 698 coupled to the valve assembly 672 with respect to manifold portion 674/684 to facilitate connection of flowline 678 between the valve assembly 672 and the valve assembly 674. As depicted, the flowline 678 comprises two elbow blocks 678a-678b connected by an intermediate swivel joint 678c, and two elbow blocks 678d-678e connected by an intermediate swivel joint 678f, with elbow block 678a connected to tee 698 on skid 612 and elbow block 678d connected to tee 699 on skid 14. In certain embodiments, the elbow blocks and swivel joints 678a-f may be connected to the respective tees 698, 699 when the adjustable skids 612, 614 are deployed to the wellsite. Between elbow blocks 678b and 678e are connected one or more pipe spools 678g that can accommodate the distance between the manifold portions on the skids 612 and 614. The elbow block/swivel connections may further facilitate connection between the manifold portions on the skids by allowing for additional adjustability with respect to the angle and distance between the manifold portions on the skids 612, 614. In some embodiments, the elbow block/swivel connections in

the manifold flowline may be excluded, and pipe spools 678g may be connected directly to the tees 698, 699.

[0073] In another aspect, embodiments of the present disclosure relate to spacers which may form metal-to-metal seals and may be used alone in a fracture system or in combination with adjustable skids similar to those described above. When used alone, the unit flowlines/manifold flowlines may be assembled using different sized pipe spools and spacers that account for distance or angular variation between the tree and manifold skid connectors, and between the manifold skids. When used in combination with the adjustable skids, which also may be deployed without the use of spacers, the spacers may function as a gross alignment mechanism, which the adjustability in the skid may provide a fine alignment that is able to close smaller gaps. FIGS 2a-2c show example length spacer 692a deployed in unit flowline 692, length spacer 678t deployed in manifold flowline 678, and wedge spacers 694a-694b deployed in flowline 694 to account for misalignment between the manifold portion and the tree. Other orientations and placements are possible.

[0074] FIGs. 3a-3b illustrate spacers 100. A spacer 100 may include a body 102, a first end 104, a second end 106, and a bore 108 formed therethrough. The body 102 may have a single-body construction. The body 102 may have the same outer diameter along the entire length of the body 102. In some embodiments, as shown in FIGs. 3a-3b, the body 102 may have a cylindrical shape. In some embodiments, the body 102 may have any shape known in the art, such as an octagonal or other polygonal prism.

[0075] The first end 104 and the second end 106 of the spacer 100 may be configured to seal against components, such as piping components of a fracture system, which are disposed against the ends 104, 106. The ends 104, 106 may form metal-to-metal seals. The ends 104, 106 may be configured to form metal-to-metal seals with adjacent components, when a known amount of pressure is applied to the junction of an end 104, 106 and an adjacent component. Pressure may be applied to the junction, for example, by connecting bolts between two flanges of two components (not shown) disposed at either end 104, 106 of a spacer 100. The spacer 100 may fit within a ring of bolt holes (not shown) formed in adjacent components.

[0076] The profile of an end 104, 106 may promote the formation of a metal-to-metal seal with an adjacent component. In some embodiments, as shown in FIGs. 3a-3b, a first end 104 may have a stepped profile, which may include a raised region 110 proximate the bore 108 and a depressed region 112 proximate an outer surface 114 of the body 102. The depressed region 112 may be a centering ring which may increase the ease with which the spacer 100 may be fit against an adjacent component. The regions 110, 112 may be normal to the bore 108. A step 116 may be formed between the raised region 110 and the depressed region 112 and may be normal to the regions 110, 112. The profile may further include a trough 118 formed adjacent the bore 108 and interior to the raised region 110. The trough 118 may be configured to receive a protruding portion of an adjacent component (not shown). The trough 118 may be tapered on either or both sides to improve a fit with the adjacent component.

[0077] The spacer 100 may include a reinforced wall 120 formed around the bore 108 and extending the length of the bore 108. The reinforced wall 120 may be resistant to erosion and corrosion, particularly erosion and corrosion which may be caused by fracture fluids. The reinforced wall 120 may be formed of a different material than the body 102.

[0078] The dimensions of the spacer 100 may be determined by the system in which the spacer 100 is configured to be used. In some embodiments, the spacer 100 may have a length between one-half and thirty-six inches, between one and twenty-four inches, or between one-and-a-half and twelve inches. In some embodiments, the bore 108 may have a diameter between one and twelve inches, between three and ten inches, or about seven inches. In some embodiments, the spacer 100 may have an outer diameter of between six and twenty-four inches, between eight and eighteen inches, or between twelve and sixteen inches. In some embodiments, the spacer 100 may have any dimensions known in the art.

[0079] In some embodiments, as shown in FIGs. 3a-3b, the first end 104 and the second end 106 may be parallel to each other and the bore 108 may be linear. In some embodiments, an angle may be formed between the first end 104 and the second end 106. The bore 108 may not be linear, but may rather be angled or

curved. Such embodiments will be discussed in more detail with respect to FIGs. 5a-5c.

[0080] In another aspect, embodiments of the present disclosure relate to spacers which may be configured to be used in a fracture system. FIGs. 4a-4b illustrate spacers 200. A spacer 200 may include a body 202, a first end 204, a second end 206, a bore 208 formed therethrough, and a connector 222.

[0081] The body 202 may have a single-body construction. The body 202 may have the same outer diameter along the entire length of the body 202. In some embodiments, as shown in FIGs. 4a-4b, the body 202 may have a cylindrical shape. In some embodiments, the body 202 may have any shape known in the art, such as an octagonal or other polygonal prism.

[0082] The connector 222 may be configured to connect the spacer 200 to adjacent components (not shown), such as piping components of a fracture system. In some embodiments, such as shown in FIGs. 4a-4b, the connector 222 may comprise bolt holes 224 formed through the body 202 and extending from the first end 204 to the second end 206. The bolt holes 224 may be parallel to the bore 208. In some embodiments, the connector 222 may be any type of connector known in the art.

[0083] The first end 204 and the second end 206 of the spacer 200 may be configured to seal against components disposed against the ends 204, 206. The ends 204, 206 may form metal-to-metal seals. The ends 204, 206 may be configured to form metal-to-metal seals having a desired strength with adjacent components, when a known amount of pressure is applied to the junction of an end 204, 206 and an adjacent component.

[0084] The profile of an end 204, 206 may promote the formation of a metal-to-metal seal with an adjacent component. In some embodiments, as shown in FIGs. 4a-4b, a first end 204 may have a stepped profile, which may include a raised region 210 proximate the bore 208 and a depressed region 212 proximate an outer surface 214 of the body 202. The bolt holes 224 of the connector 222 may be formed through the depressed region 212. Compared to the spacer 100 shown in FIGs. 3a-3b, the spacer 200 may have a larger depressed region 212 and/or a larger outer diameter. The regions 210, 212 may be normal to the bore 208. A step 116 may be formed

between the raised region 210 and the depressed region 212 and may be normal to the regions 210, 212. The profile may further include a trough 218 formed adjacent the bore 208 and interior to the raised region 210. The trough 218 may be configured to receive a protruding portion of an adjacent component (not shown). The trough 218 may be tapered, which may promote the formation of a seal between the spacer 200 and adjacent components.

[0085] The spacer 200 may include a reinforced wall 220 formed around the bore 208 and extending the length of the bore 208. The reinforced wall 220 may be resistant to erosion and corrosion, particularly erosion and corrosion which may be caused by fracture fluids. The reinforced wall 220 may be formed of a different material than the body 202.

[0086] The dimensions of the spacer 200 may be determined by the system in which the spacer 200 is configured to be used. In some embodiments, the spacer 200 may have a length between one-half and thirty-six inches, between one and twenty-four inches, or between one-and-a-half and twelve inches. In some embodiments, the bore 208 may have a diameter between one and twelve inches, between three and ten inches, or about seven inches. In some embodiments, the spacer 200 may have an outer diameter of between six and twenty-four inches, between eight and eighteen inches, or between twelve and sixteen inches. In some embodiments, the spacer 200 may have any dimensions known in the art.

[0087] In some embodiments, as shown in FIGs. 4a-4b, the first end 204 and the second end 206 may be parallel to each other and the bore 208 may be linear. In some embodiments, an angle may be formed between the first end 204 and the second end 206. The bore 208 may not be linear, but may rather be angled or curved. Such embodiments will be discussed in more detail with respect to FIGs. 5a-5c.

[0088] A spacer in accordance with embodiments of the present disclosure may be a wedge spacer. FIGs. 5a-5c illustrate a wedge spacer 300, showing a cross-section and a perspective view, respectively. The wedge spacer 300 may include the same elements as the spacer 200 described above with respect to FIGs. 4a-4b.

[0089] The body 302 of the spacer 300 may have a single body construction as discussed above. The body 302 may have a wedge shape, such that an angle "A" may be formed between the first end 304 and the second end 306 of the spacer 300. The body 302 may have a single outer diameter along the length of the body 302. The body 302 may not have a single length, but rather may have a maximum length " L_{max} " at a first side 326 and a minimum length " L_{min} " at a second side 328. In some embodiments, as shown in FIGs. 5a-5c, the outer surface 314 of the spacer 300 may extend linearly from the first end 304 to the second end 306. In some embodiments, the outer surface 314 may be curved or angled.

[0090] The bore 308 of the spacer 300 may be angled or curved. In some embodiments, as shown in FIGs. 5a-5c, the bore 308 may include multiple linear segments. A first segment 330a may be formed proximate the first end 304 and may be normal to the first end 304. The first segment 330a may have a single length. A second segment 330b may be formed proximate the second end 306 and may be normal to the second end 306. The second segment 330b may have a single length. An intermediate segment 330c may be formed between the first segment 330a and the second segment 330b. The intermediate segment 330c may have a maximum length at the first side 326 and a minimum length at the second side 328. The ends of the intermediate segment 330c may form an angle "A" relative to each other. In some embodiments, the ends of the intermediate segment 330c may form an angle other than "A" relative to each other. In some embodiments, the bore 308 may include any number of linear or curved segments.

[0091] A reinforced wall 320 may be formed around the bore 308 as described above. In some embodiments, the reinforced wall 320 may be formed in segments corresponding to the segments 330a-330c of the bore. In such embodiments, one or more of the segments of the reinforced may be removable from the spacer 300. Such a design may allow segments of the reinforced wall 320 to be removed and replaced as they become worn.

[0092] The ends 302, 304 of the spacer 300 may have a profile including some or all of the elements described above with respect to FIGs. 3-4. For example, the ends 302, 304 may each include a trough 318.

[0093] The connector 322 of the spacer 300 may comprise screw holes 332 formed in the body 302 at the first end 304 and the second end 306. The screw holes 332 may extend a distance from the ends 304, 306, such that the distance is equal to or less than half of " L_{min} ." The screw holes 332 formed at the first end 304 may be normal to the first end 304. The screw holes 332 formed at the second end 306 may be normal to the second end 306. In some embodiments, the spacer 300 may not include a connector 322. In such an embodiment, the spacer 300 may include a depressed region/centering ring as illustrated in FIGs. 3a-3b.

[0094] In some embodiments, the connector 322 may comprise any means of connection in the art. For example, as illustrated in FIGs. 4a-4b, the connector 322 may include bolt holes which extend from the first end 304 to the second end 306. The bolt holes may be parallel to the outer surface 314 of the body 302 and to the intermediate segment 330c of the bore 308. The bolt holes may be tapped proximate the ends 304, 306 of the spacer 300 such that a nut or other element may be tightened against the ends 304, 306.

[0095] The spacer 300 may include circumferential connectors 334 formed in the outer surface 314 of the body 302. The circumferential connectors 334 may be screw holes or any other type of connector known in the art. The connectors 334 may not extend to the bore 308. The circumferential connectors 334 may be used to connect the spacer 300 to elements adjacent to the ends 304, 306 of the spacer 300 or to elements adjacent the outer surface 314. Flat faces 336 may be formed on the outer surface 314 of the body 302 proximate the circumferential connectors 334. The circumferential spacers 334 may be used to orient the spacer 300 relative to adjacent components (not shown).

[0096] FIG. 5c illustrates a wedge spacer 300 configured for use with a clamping style connection. The spacer 300 may include a first flange 348 formed at the first end 304 and a second flange 350 formed at the second end 306. Clamp connectors 352, 354 may be used to connect the spacer 300 to adjacent components via the flanges 348, 350.

[0097] In another aspect, the present disclosure relates to a fracture system including one or more spacers as described above with respect to FIGs. 3-5 and/or one or more

adjustable skids as described above with respect to FIGs. 2a-2c. A fracture system may include only spacer(s), only adjustable skid(s), or both spacer(s) and adjustable skid(s). A fracture system may include spacers in accordance with any one of the Figures, may include multiple spacers in accordance with different Figures, or may include spacers having features in accordance with multiple Figures.

[0098] Returning to FIGs. 2a-2c, the lateral extension 664 of the tree 654 may be oriented such that an axis of the lateral extension 664 is substantially vertical. However, the axis may deviate slightly from a vertical orientation. The manifold connector 684 may be oriented such that an axis of the manifold connector 684 is substantially vertical. However, the axis may deviate slightly from a vertical orientation. In some embodiments, the deviation of an axis of a lateral extension 664 of a connector 684 may be about five to ten degrees. The lateral extension 664 and the manifold portion 674 may be arranged such that the lateral extension 664 is disposed directly above the connector 684. However, there may be a slight offset between them.

[0099] The unit flowline 694 may be configured to correct for deviations in the orientations and offsets between the lateral extension 664 and the connector 684, such that the flowline 694 may form robust seals with both the lateral extension 664 and the connector 684. The flowline 694 may include one or more spacers 694a and 694b. The spacers 694a and 694b may be any spacer in accordance with the description above.

[00100] Additionally, or alternatively, the adjustable skid 614 may be configured to correct for deviations in the orientations of the lateral extension 664 and the connector 684 and offsets between the lateral extension 664 and the connector 684, such that the flowline 694 may form robust seals with both lateral extension 664 and the connector 684. In some embodiments, spacers 600 may correct gross deviations and an adjustable skid 676 may provide further fine adjustment of the deviations.

[00101] The spacers may be chosen and the skid 614 may be adjusted such that the flowline 694 extends precisely from the lateral extension 664 to the connector 684. The spacers of the flowline 694 may or may not be wedge spacers. If any of the one or more spacers is a wedge spacer, the flowline 694 may be angled. If more than

one spacer is a wedge spacer, the flowline 694 may be angled in one direction or in more than one direction. The spacers may have any length as described above. The unit flowline 694 may be substantially vertical.

[00102] Additionally, the tees 698 and 699 respectively disposed on skids 612 and 614 may be oriented such that an axis of each connector is substantially horizontal. However, the axes may deviate slightly from a horizontal orientation. For example, an axis may deviate from a horizontal orientation by about five to ten degrees. The tees 698 and 699 may be arranged such that they are directly lateral each other. However, there may be a slight offset between the tees 698 and 699.

[00103] The manifold flowline 678 may be configured to correct for deviations in the orientations of the tees 698 and 699 and offsets between the tees 698 and 699, such that the flowline 678 may form robust seals with both tees 698 and 699. The flowline 678 may include one or more spacers 678t. The spacers 678t may be any spacer in accordance with the description above. The flowline 678 may further include one or more traditional pipe joints and one or more swivel joints. The swivel joints 688 may be connected between the spacers if the flowline 678 includes more than one spacer and between spacers, the traditional pipe joints, and the tees 698 and 699, as shown in FIGs. 2a-2c.

[00104] Additionally, or alternatively, the adjustable skid 676 may be configured to correct for deviations in the orientations of the tees 698 and 699 and offsets between the tees 698 and 699, such that the flowline 692 may form robust seals with both tees 698 and 699. In some embodiments, spacers may correct gross deviations and an adjustable skid 676 may provide further fine adjustment of the deviations.

[00105] The spacers 600 may be chosen such that the flowline 678 extends precisely between tees 698 and 699. The spacers of the flowline 678 may or may not be wedge spacers. If any of the one or more spacers is a wedge spacer, the flowline 678 may be angled. If more than one spacer is a wedge spacer, the flowline 678 may be angled in one direction or in more than one direction. The spacers may have any length as described above. The fracture flowline 678 may be substantially horizontal.

[00106] A fracture system 600 may include one or more unit flowlines and one or more manifold flowlines. The unit flowlines may or may not include the same components as each other. The components of the unit flowlines may be determined by the spacing and orientation between each manifold portion/skid and Christmas tree pair. The manifold flowlines may or may not include the same components as each other. The components of the manifold flowlines may be determined by the spacing between each pair of consecutive manifold portions/skids.

[00107] The manifold flowlines may form a single flowpath through which fluid may be flowed. The manifold portions/skids may each include one or more valves, for example, as shown in FIGs. 2a-2c, each manifold may include two valves. The valves may allow flow to each Christmas tree to be controlled independently, such that flow to a single tree may be shut off while flow to other trees in the fracture system may continue.

[00108] In another aspect, embodiments of the present disclosure relate to methods of assembling and using a fracture system. The fracture system may have features as described above, and may include spacers and/or adjustable skids in accordance with any embodiment or combination of embodiments described above.

[00109] With reference to FIGs. 2a-2c, steps of the method will be described below. A method in accordance with the present disclosure may include all of the steps described, some of the steps, or a combination of the steps described below and other steps which are not described.

[00110] One or more Christmas trees 652-656 may be installed directly or indirectly on a substrate 690. In some embodiments, a lower portion of a Christmas trees 652-656 may be installed on the substrate 690 and an upper portion of the Christmas trees 652-656 may be installed on the lower portion. The respective lateral extensions 662-666 of the Christmas trees 652-656 may then be installed, or alternatively, the lateral extensions 662-666 of the Christmas trees 652-656 may be pre-connected to a portion of the respective Christmas trees 652-656 before the Christmas trees 652-656 are fully assembled.

[00111] The method may further include positioning a first portion of a manifold at least partially under a lateral extension of a first Christmas tree, wherein the first

portion of the manifold is disposed on a first adjustable skid. As depicted, a first portion of manifold 670 may comprise valve assembly 672, connector 682, and tee 698, all of which are disposed on adjustable skid 612. The connector 682 may be positioned at least partially under the block tee in the lateral extension 662 of tree 652. The location at which the adjustable skid 612 is disposed may be determined using laser technology based on the location and orientation of the Christmas trees 652. The adjustable skid 612 may be positioned in the desired location using external equipment (not shown) such as a crane or a forklift.

[00112] The method may further comprise altering an orientation of the first portion of the manifold with respect to the lateral extension using, at least in part, the adjustable skid. As depicted as described above, the adjustable skid 612 may be used alone, or in combination with various spacers, to align the connector 682 with the lateral extension 662 of tree 652. For example, the adjusters 607a-607b of the skid 612 may be configured such that the connector 692 is aligned with the lateral extension 662 or the unit flowline 692 which may, in certain embodiments, be assembled and connected to the lateral extension 662 before the connector 682 is in final alignment. Configuring the adjusters 607a-607b may comprise, for instance, commanding a linear position/length of each adjuster 607a-607b. Additionally, with reference to the adjustable skid 812 in FIGs. 6a-6a, altering an orientation of the first portion of the manifold with respect to the lateral extension may comprise raising or lowering the manifold portion 872 using one or more of the jacks 809a-809d coupled to the corners of the base platform 803. Taken together, the configuration of the adjusters may be used to position the manifold portion precisely under a lateral extension of a tree or against the unit flowline 692.

[00113] The method may further include establishing a fluid connection between the first portion of the manifold and the first Christmas tree. As depicted in FIGs. 2a-2c, the fluid connection between the connector 684 and the lateral extension 662 of the tree is provided through unit flowline 692, and establishing the fluid connection may include assembling the unit flowline 692 and attaching it to the lateral extension 662 and the connector 682. In certain embodiments, e.g., where the alignment between the connector 682 and lateral extension 662 is not precise, the unit flowline 692 may be assembled from spacers 600 to ensure proper connection between the connector

682 and lateral extension 662 without putting unnecessary bending loads on the trees of other equipment. The swivel joint incorporated into the connector 682 may allow for rotational freedom between the connector 682, flowline 692, and lateral extension 662 to ensure proper alignment of bolt holes for flanged connection. Similar functionality can be provided by incorporating the swivel joint into the flowline 692.

[00114] The fracture system 670 may then be used in a fracture operation or another wellbore operation. For example, a fracture fluid may be injected through the fracture system 670.

[00115] In certain embodiments, the method further includes performing the above steps with respect to a second manifold portion, adjustable skid, and tree, e.g., valve assembly 674/connector 684, adjustable skid 614 and lateral extension 664. After a fluid connection, e.g., unit flowline 694, is established between the second manifold portion and the second tree, the method may further include altering an orientation of the second portion of the manifold with respect to the second adjustable skid to facilitate connection with the first portion of the manifold. With reference to FIGs. 2a-2c, this step may be performed, for instance, by pivoting the valve assembly 674/connector 684/tee 699 on the adjustable skid 614 to facilitate connection of the manifold flowline 678 between the tee 699 of the adjustable skid 614 and the tee 698 of the adjustable skid 612. In certain embodiments, the manifold flowline 678 may comprise one or more spacers and/or swivel joints to facilitate connection between the tees 698, 699 where the alignment is not precise.

[00116] To the extent both spacers and adjustable skids are used, the spacers may be used to correct for gross deviations in the relative orientations and positions of the connectors and lateral extensions, while the adjustable skids may be used to provide fine adjustments to the orientation and position of the tree connector 682, 684. In some embodiments of the method, only the spacers or only the adjustable skids may be used.

[00117] As described above, laser positioning technology and other measurement methods may be used to position the skids and manifold portions with respect to the lateral extensions of the trees. Laser positioning technology may also be used to

position the manifold skids with respect to each other, e.g., such that the tees 698, 698 of skids 612, 614 in FIGs. 2a-2c substantially align with each other. Offsets in the relative orientations and positions between the manifold portions and trees may also be measured once the manifold portions are in place. These measured offsets may be used to determine how the unit flowlines and manifold flowlines are to be assembled. For instance, when spacers are being used without adjustable skids, the measured offsets may be used to select the combination of wedge and other spacers to make a precise connection between the manifold portions and trees and between the manifold portions themselves. Similar selections can also be made when adjustable skids are in use to the extent the offsets fall outside of the adjustable range provided by the skids.

[00118] The spacers, skids, system, and method of the present disclosure may provide advantages compared to the equipment, systems, and methods currently used in fracture operations. Systems including the skids and/or spacers disclosed herein may include more precise connections between components, such that adjacent components have a significantly reduced, or even negligible, offset in location and orientation. This may allow components to form stronger seals, which may in turn prevent damage to or failure of the system. This may be particularly helpful when erosive or corrosive fracture fluids are injected through the system, as the fluids may erode/corrode component junctions with small offsets, such that the offsets become enlarged, which may shorten the lifespan of components or the entire system, or even lead to catastrophic failure of the system.

[00119] The system of the present disclosure may be able to accommodate offsets in orientation and location of system components from their planned location. Offsets may occur due to human error in installation of components, settling/shifting of a substrate on which components are installed, manufacturing errors in components, or other causes. Because of the significant space between components such as Christmas trees and manifolds, even small offsets in a single component may lead to significant offsets in the necessary connection. Therefore, it may be important to account for these offsets when connecting flowlines between components.

[00120] Compared to currently used systems, the system of the present disclosure may require fewer components to make connections. This may reduce the time necessary to assemble, test, clean, disassemble, or perform other system operations. This may also make the system less prone to failure as there are fewer connection points which may be likely to fail. The system of the present disclosure may be easy to assemble and use, may have a relatively small profile, and may be more robust than currently used systems, especially in use with erosive and corrosive fluids.

[00121] While the disclosure includes 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 present disclosure. Accordingly, the scope should be limited only by the attached claims.

CLAIMS

What is claimed is:

1. A frac transfer system comprising:
 - a Christmas tree having a lateral extension; and
 - a manifold in fluid communication with the Christmas tree,wherein a portion of the manifold is positioned at least partially under the lateral extension of the tree and disposed on an adjustable skid that facilitates connection between the portion of the manifold and the lateral extension of the tree.
2. The frac transfer system of claim 1, wherein the adjustable skid comprises
 - a base platform;
 - one or more supports disposed on the base platform; and
 - one or more adjusters disposed on the supports, wherein the adjusters are configured to provide relative movement between the portion of the manifold and the base platform.
3. The frac transfer system of claim 2, wherein the adjusters comprise a pivot joint and one or more wheels that are configured to engage with and travel along a track coupled to the supports.
4. The frac transfer system of claim 2 or 3, wherein the adjustable skid further comprises one or more secondary adjusters coupled to the base platform and configured to alter the relative position between the base platform and the ground when the adjustable skid is deployed.
5. The frac transfer system of any of the preceding claims, further comprising a flowline coupled between the portion of the manifold and the lateral extension of the Christmas tree, wherein the flowline includes a swivel joint.
6. The frac transfer system of claim 5, wherein the unit flowline further comprises at least one of a spacer and a wedge joint.
7. The frac transfer system of any of the preceding claims, further comprising a second Christmas tree, wherein a second portion of the manifold is disposed on a second adjustable skid that facilitates connection between the second portion of the manifold

- and the second Christmas tree and between the first portion of the manifold and the second portion of the manifold.
8. The frac transfer system of claim 7, further comprising a manifold flowline connecting the portion of the manifold to the second portion of the manifold, wherein the manifold flowline comprises a plurality of pipe spools.
 9. The frac transfer system of claim 8, wherein the manifold flowline comprises at least one of a spacer and a wedge joint.
 10. The frac transfer system of claim 8 or 9, wherein the manifold flowline further comprises at least two elbow blocks and a swivel joint positioned therebetween.
 11. A method, comprising:
 - positioning a first portion of a manifold under a lateral extension of a first Christmas tree, wherein the first portion of the manifold is disposed on a first adjustable skid;
 - altering an orientation of the first portion of the manifold with respect to the lateral extension using, at least in part, the adjustable skid;
 - establishing a fluid connection between the first portion of the manifold and the first Christmas tree.
 12. The method of claim 11, further comprising the step of after the first portion of the manifold is connected to the first Christmas tree, altering an orientation of the first portion of the manifold with respect to the adjustable skid to facilitate connection between the first portion of the manifold and the second portion of the manifold.
 13. The method of claim 11 or 12, wherein altering the orientation of the first portion of the manifold with respect to the lateral extension using, at least in part, the adjustable skid comprises raising or lowering the first portion of the manifold with respect to the lateral extension.
 14. The method of claim 13, wherein raising or lowering the first portion of the manifold with respect to the lateral extension comprises operating at least one jack coupled to the adjustable skid to raise or lower the adjustable skid.
 15. The method of any of claims 11 through 14, further comprising
 - positioning a second portion of a manifold under a lateral extension of a second Christmas tree, wherein the second portion of the manifold is disposed on a first adjustable skid;

- altering an orientation of the second portion of the manifold with respect to the lateral extension using, at least in part, the second adjustable skid of the second Christmas tree;
- establishing a fluid connection between the second portion of the manifold and the second Christmas tree;
- after the second portion of the manifold is connected to the second Christmas tree, altering an orientation of the second portion of the manifold with respect to the second adjustable skid to facilitate connection with the first portion of the manifold.
16. The method of any of claims 11 through 15, further comprising the step of connecting the first portion of the manifold to the lateral extension of the first Christmas tree using at least one of a spacer and a wedge joint.
17. A spacer comprising:
- a body having a first end and a second end; and
 - a bore extending therethrough,
- wherein the body has an outer surface,
- wherein the first end and the second end are configured to form metal-to-metal seals and
- wherein the first end and the second end are disposed at an angle greater than zero degrees to each other.
18. The spacer of claim 17, wherein each of the first end and the second end comprise a depressed region proximate the outer surface, a raised region medial to the depressed region, and a trough proximate the bore.
19. The spacer of claim 17 or 18, wherein the spacer comprises a connector formed therethrough.
20. The spacer of any of claims 17 through 19, wherein the bore comprises one or more linear segments.
21. The spacer of any of claims 17 through 20, wherein the bore is normal to both the first end and to the second end.
22. The spacer of any of claims 17 through 21, wherein an angle formed between the first end and the second end is between five degrees and ten degrees.
23. The spacer of any of claims 17 through 22, further comprising a reinforced wall disposed around the bore.

24. A frac transfer unit comprising:
- a Christmas tree;
 - a portion of a manifold; and
 - a unit flowline connected between the Christmas tree and the portion of the manifold, the unit flowline comprising at least one spacer, wherein the spacer comprises:
 - a body having a first end and a second end; and
 - a bore extending therethrough,wherein the body has an outer surface,
 - wherein the first end and the second end are configured to form metal-to-metal seals and
 - wherein the first end and the second end are disposed at an angle greater than zero degrees to each other.
25. The frac transfer unit of claim 24, wherein the unit flowline is substantially vertical.
26. The frac transfer unit of claim 24 or 25, wherein the portion of the manifold is disposed on an adjustable skid and at least partially positioned under a lateral extension of the Christmas tree.
27. The frac transfer unit of any of claims 24 through 26, wherein the frac inlet of the Christmas tree is offset from an inlet of the portion of the manifold.
28. The frac transfer unit of any of claims 24 through 27, wherein the unit flowline comprises more than one spacer, such that the unit flowline is non-linear in more than one direction.
29. A frac transfer system comprising:
- two or more frac transfer units according to any of claims 24 through 28; and
 - a manifold flowline connected between the portion of the manifold of a first of the frac transfer units and the portion of the manifold of a second of the frac transfer units, the manifold flowline comprising at least one spacer, wherein the spacer comprises:
 - a body having a first end and a second end; and
 - a bore extending therethrough,wherein the body has an outer surface,
 - wherein the first end and the second end are configured to form metal-to-metal seals and

wherein the first end and the second end are disposed at an angle greater than zero degrees to each other.

30. The frac transfer system of claim 29, wherein the manifold flowline is substantially horizontal.
31. The frac transfer system of claim 29 or 30, wherein an inlet of the manifold of the first frac transfer unit is offset from an inlet of the manifold of the second frac transfer unit.
32. The frac transfer system of claim 31, wherein the manifold flowline comprises at least one wedge spacer.
33. The frac transfer system of any of claims 29 through 32, wherein the manifold is a time and efficiency manifold or a zipper manifold.
34. The frac transfer system of any of claims 29 through 33, wherein the manifold flowline comprises more than one spacer, such that the unit flowline is non-linear in more than one direction.
35. A method comprising:
 - assembling a unit flowline, the assembling comprising connecting a piping component to a wedge spacer; and
 - connecting a Christmas tree to a manifold, via the unit flowline.
36. The method of claim 35, further comprising:
 - assembling a manifold flowline, the assembling comprising connecting a piping component to a wedge spacer; and
 - connecting the manifold to a second manifold, via the manifold flowline.
37. The method of claim 35 or 36, the method further comprising injecting a fracture fluid through the frac transfer system.

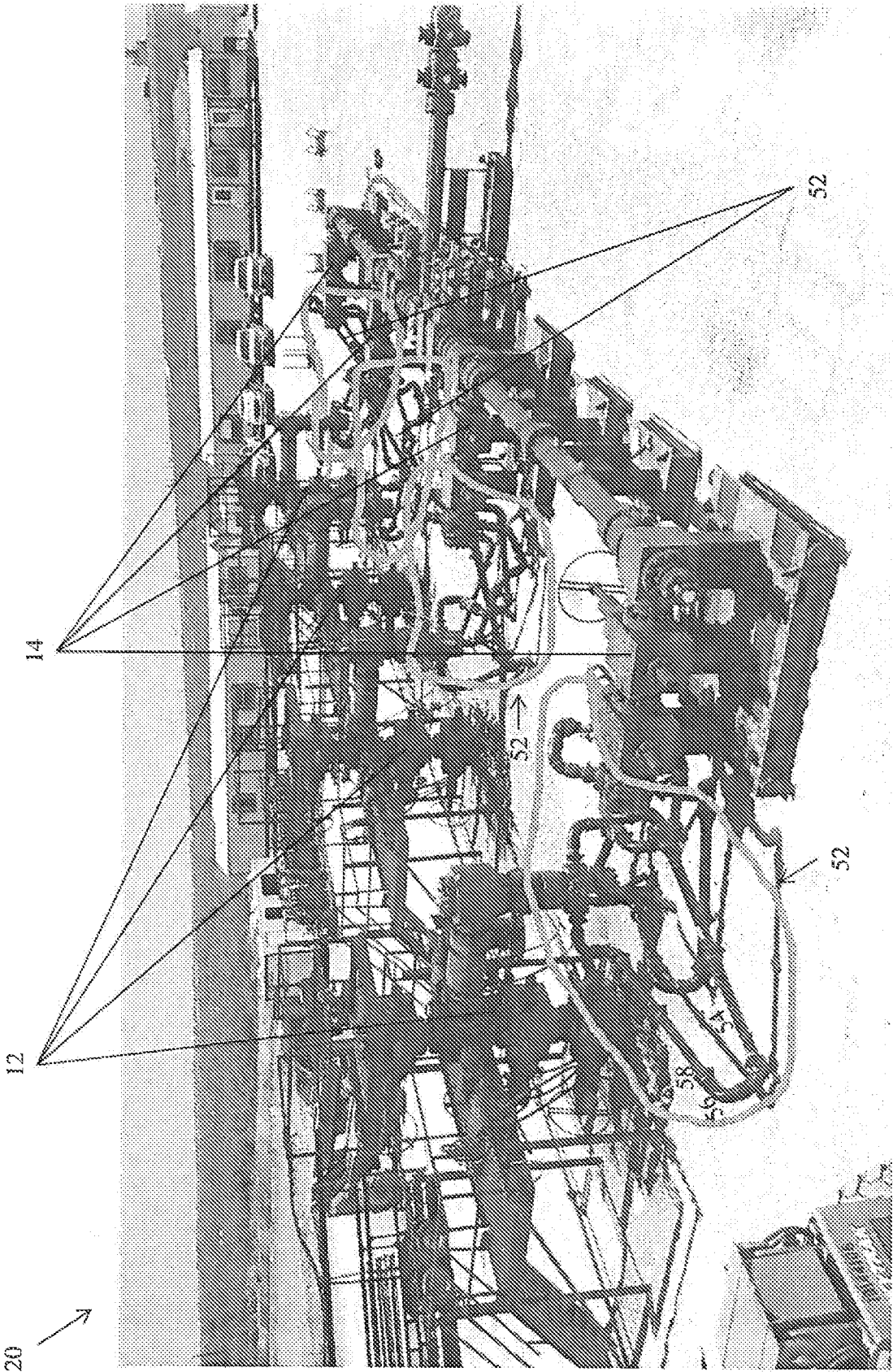


FIG. 1
Prior Art

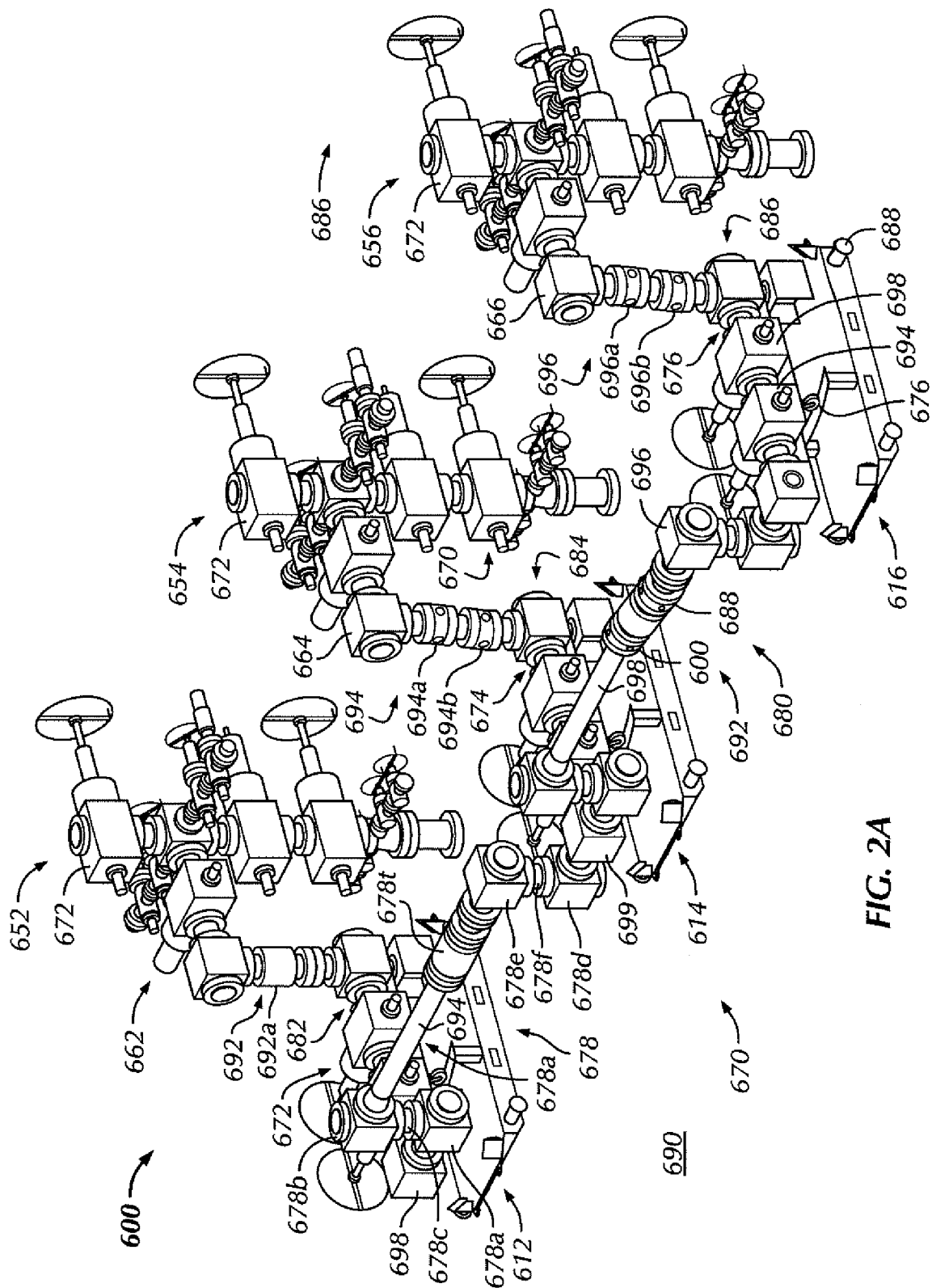


FIG. 2A

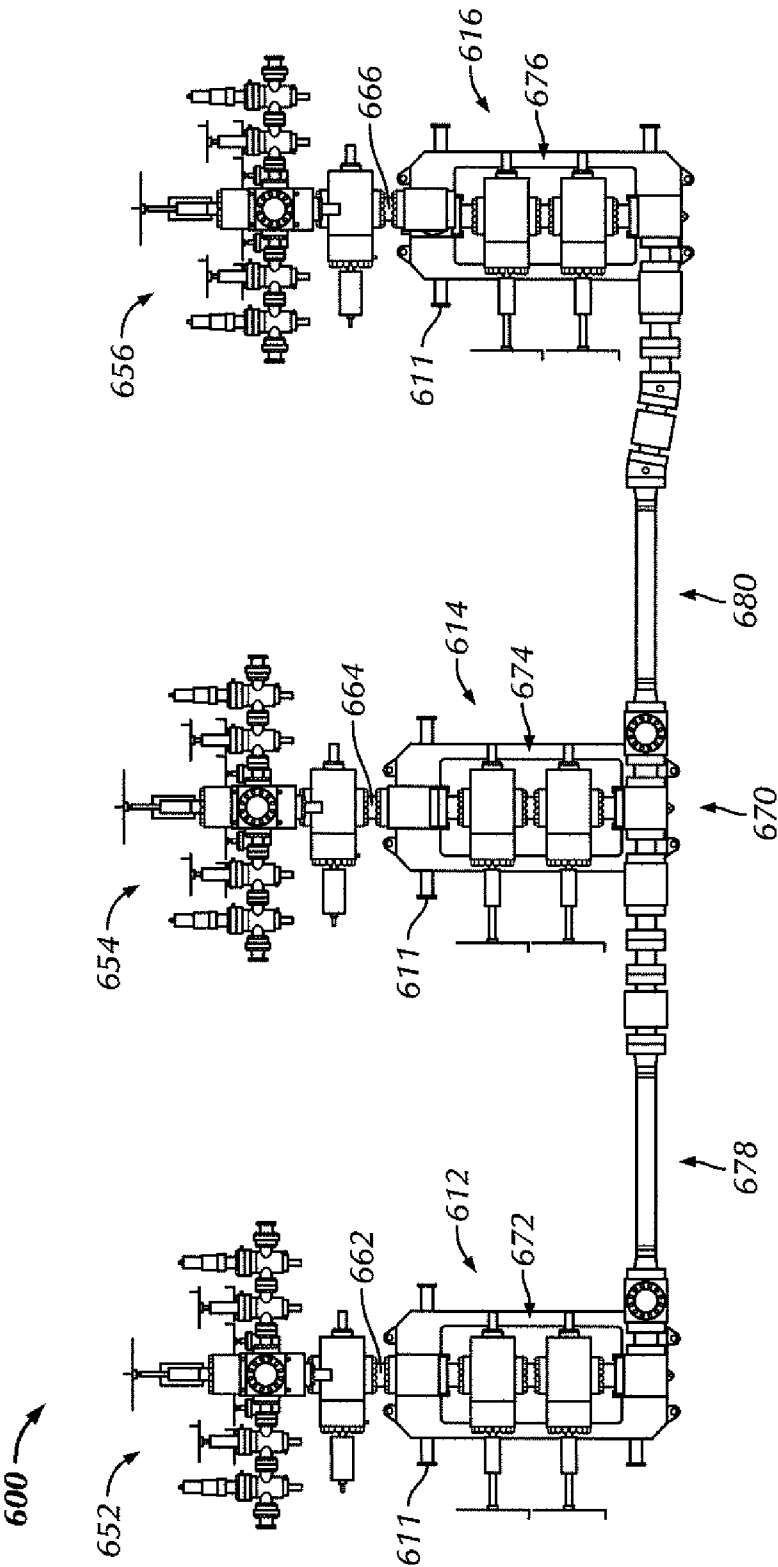


FIG. 2B

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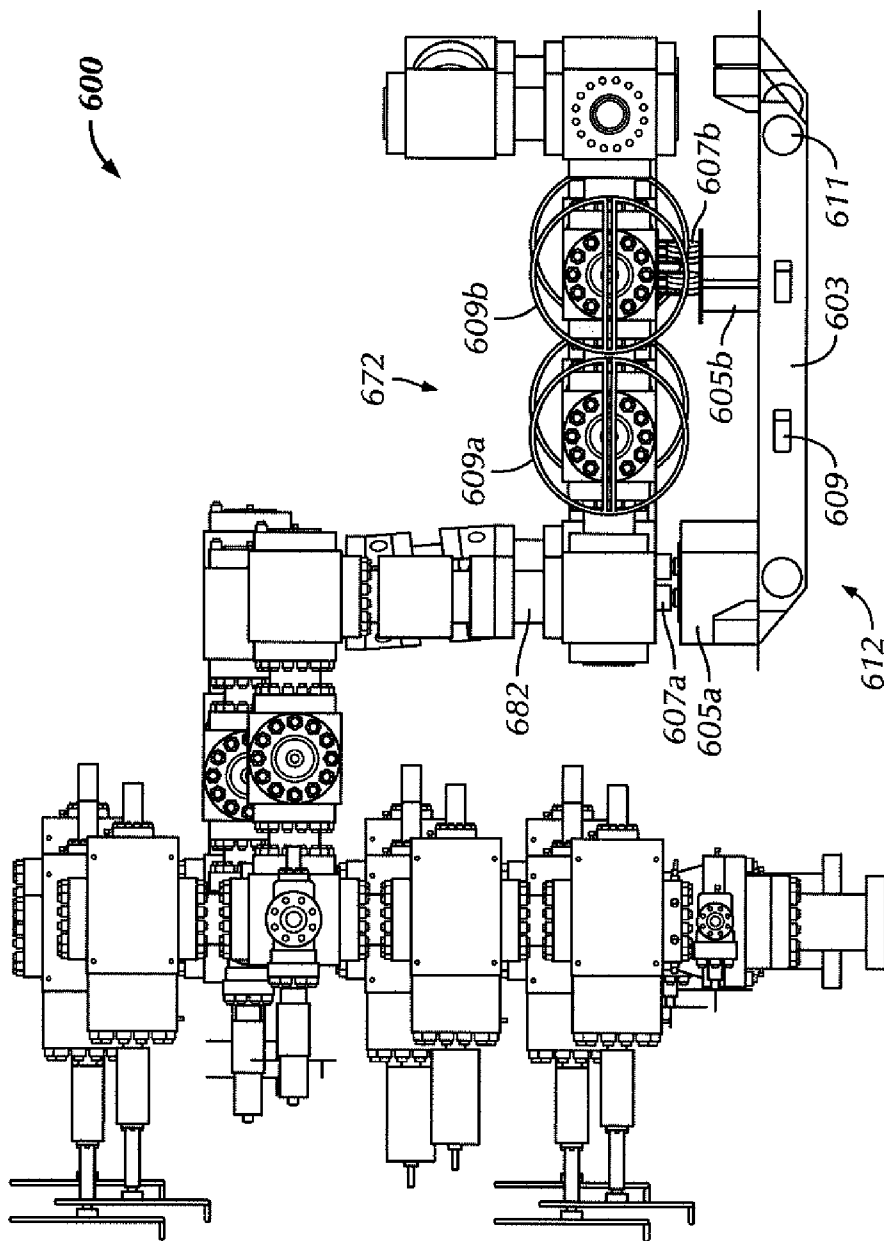


FIG. 2C

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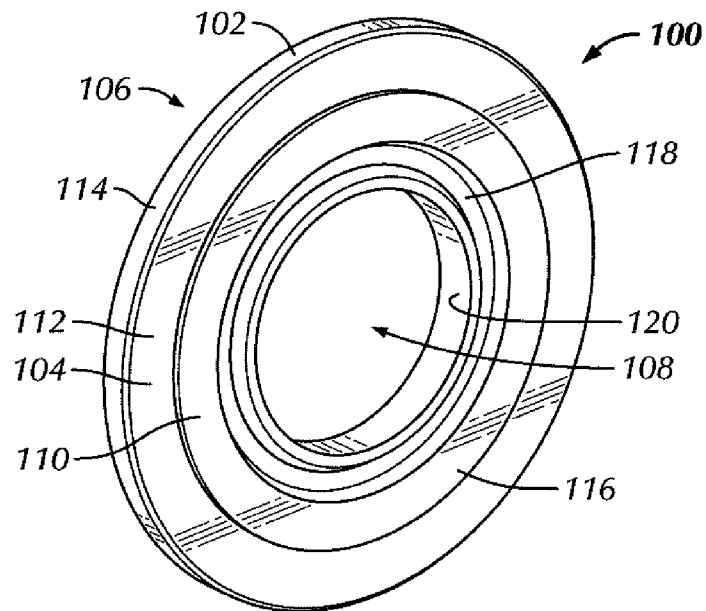


FIG. 3A

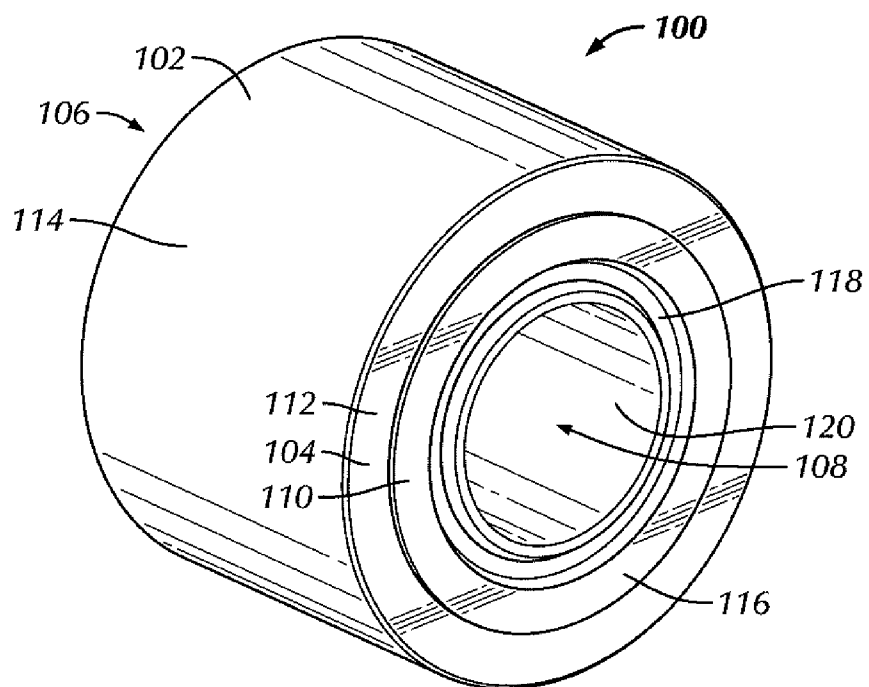


FIG. 3B

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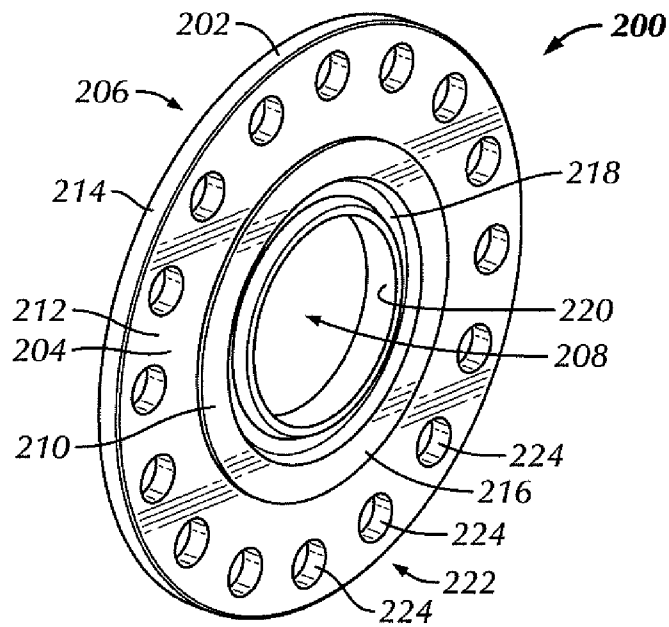


FIG. 4A

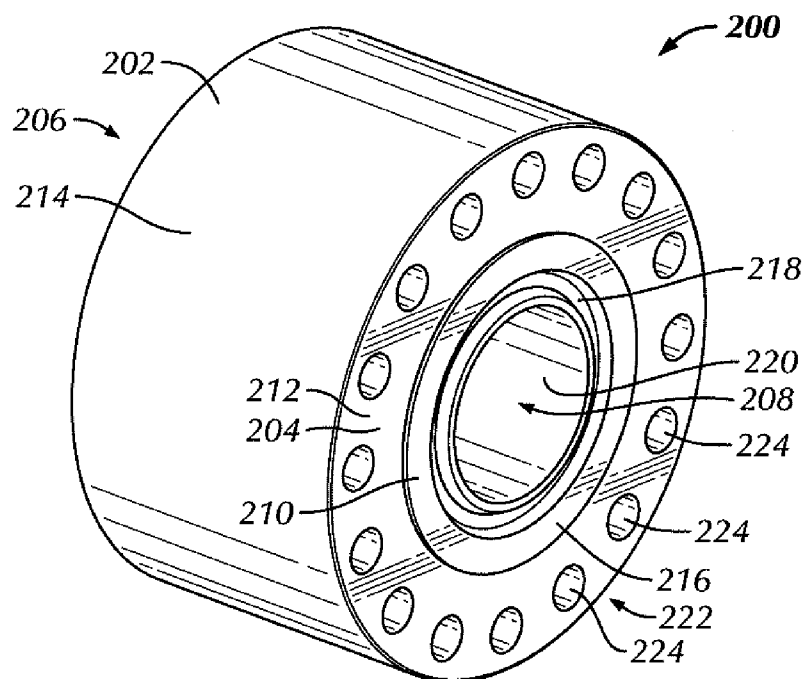


FIG. 4B

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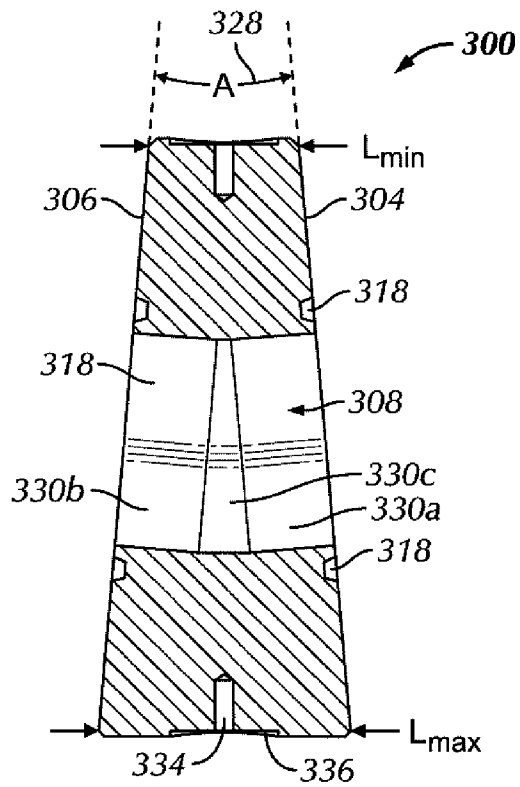


FIG. 5A

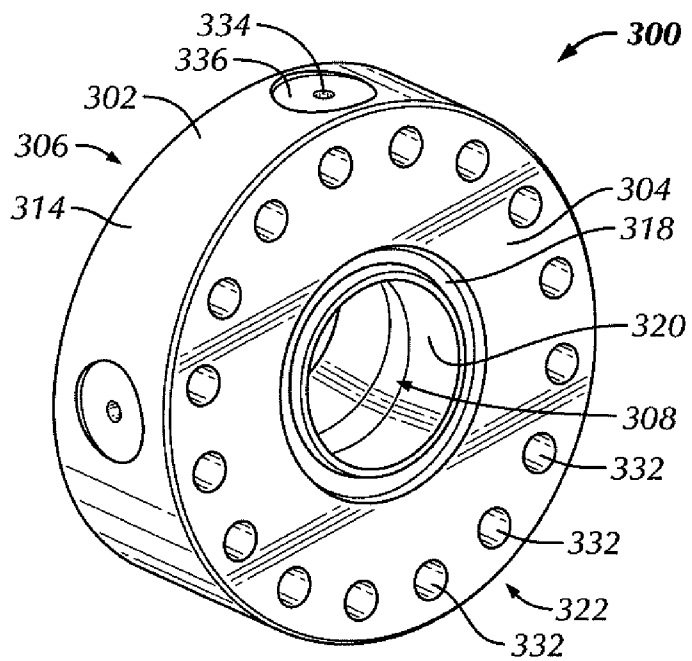


FIG. 5B

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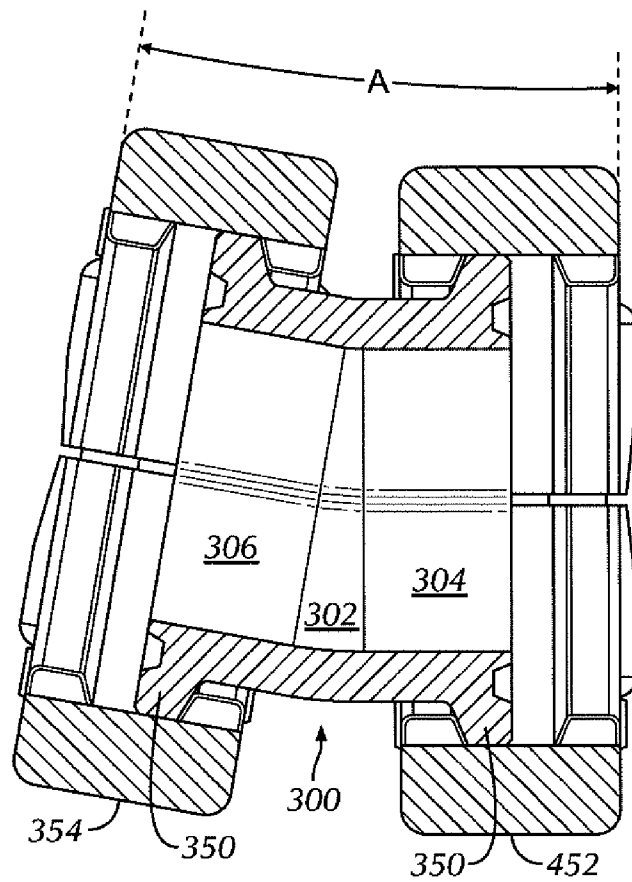


FIG. 5C

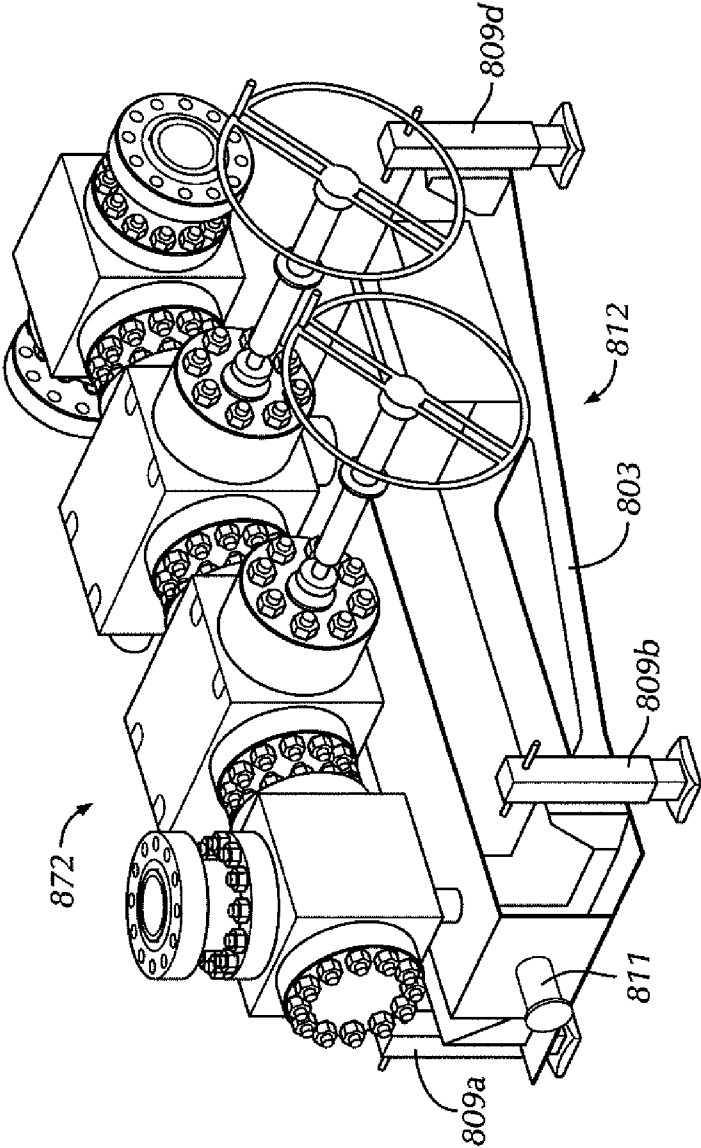


FIG. 6A

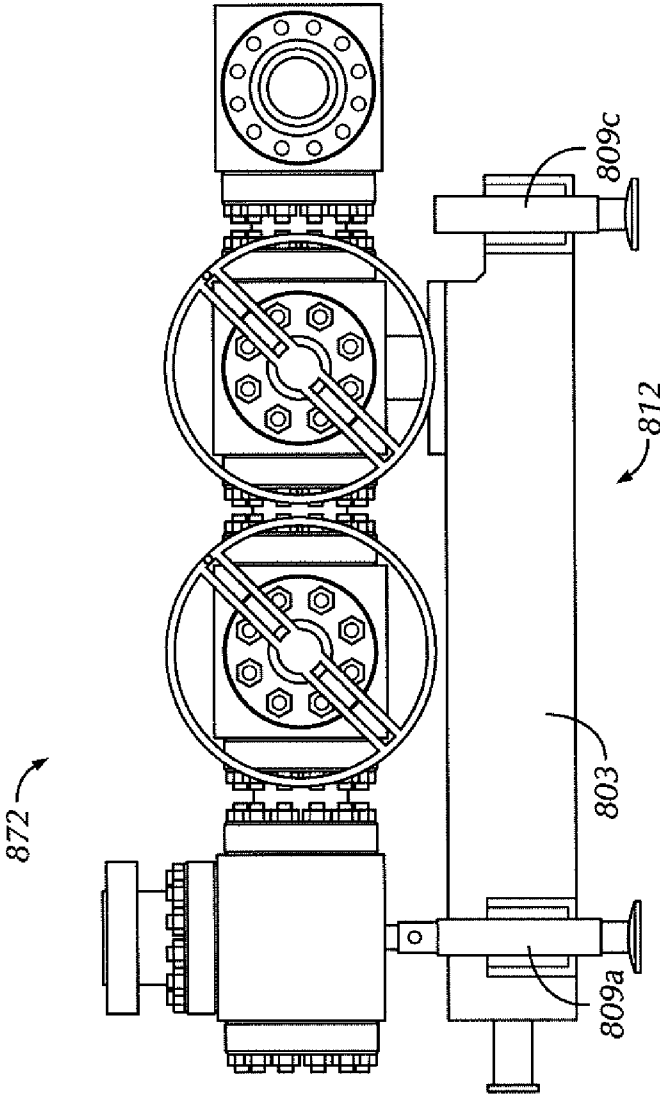


FIG. 6B

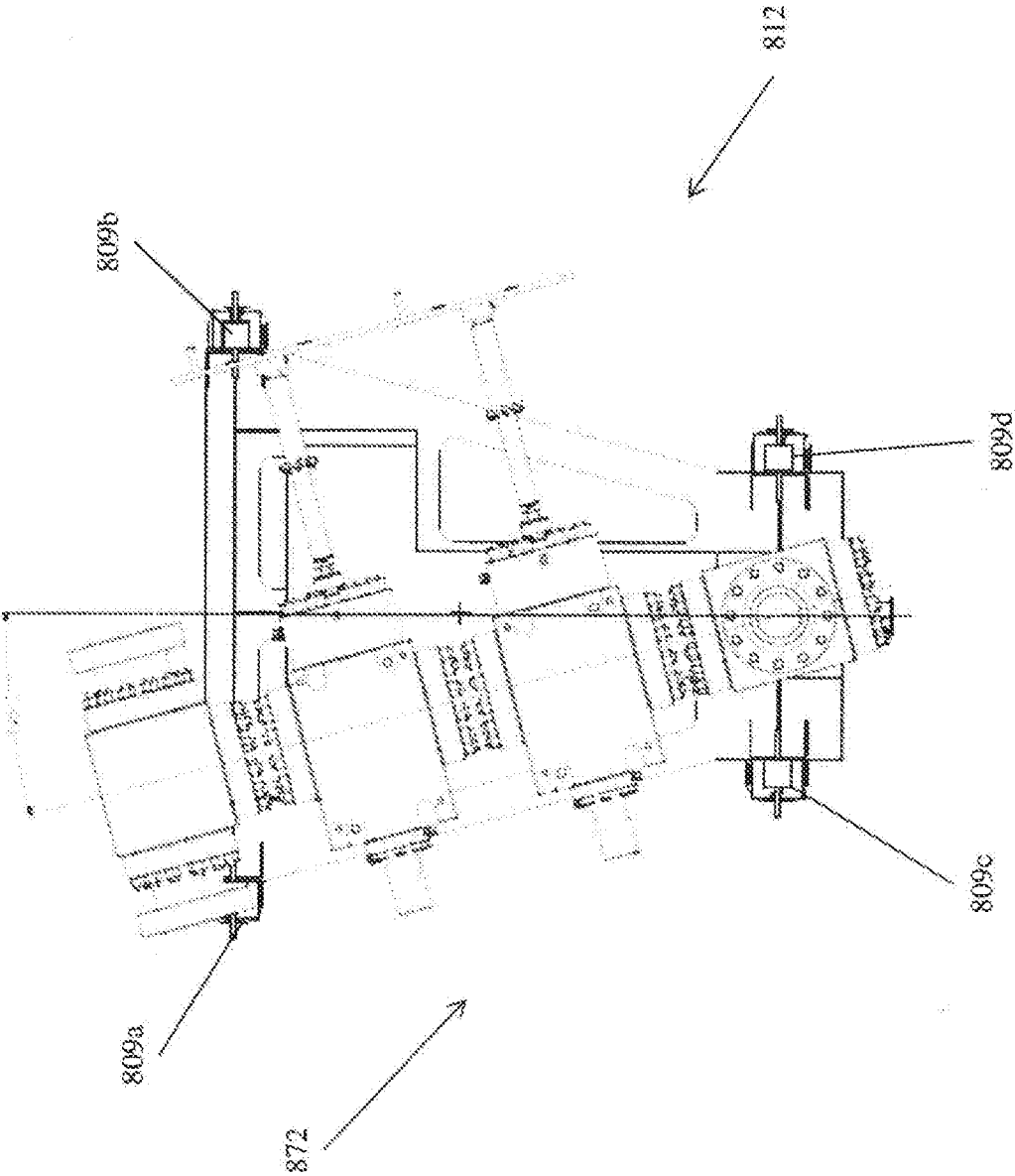


FIG. 6c

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2018/064484

A. CLASSIFICATION OF SUBJECT MATTER

INV. E21B43/26 E21B33/068 E21B34/02
ADD.

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)

E21B

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

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

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2017/275980 A1 (KAJARIA SAURABH [US]) 28 September 2017 (2017-09-28)	1,4-16
Y	paragraph [0045] - paragraph [0046]; claims 1,3; figure 10	2

X	Seaboard International: "Oil & Gas Simplified Frac Iron System", 25 April 2017 (2017-04-25), pages 1-12, XP055571625, Canada Retrieved from the Internet: URL:https://www.global.weir/assets/files/o il%20and%20gas%20ebrochures/Frac%20Iron%20 brochure%200425 5p 1!.pdf [retrieved on 2019-03-20] page 6 - page 7	1,4-16

	-/-	

☒ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

20 March 2019

Date of mailing of the international search report

20/05/2019

Name and mailing address of the ISA/

European Patent Office, P.B. 5818 Patentlaan 2
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Authorized officer

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INTERNATIONAL SEARCH REPORT

International application No

PCT/US2018/064484

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	Seaboard International: "Seaboard(TM) Zip Pac Manifold Systems Seaboard(TM) Zip Pac TS (Trac System) Seaboard(TM) Zip Pac FS (Flex System)", 1 May 2014 (2014-05-01), pages 1-2, XP055571658, Retrieved from the Internet: URL:https://www.global.weir/assets/files/p roduct%20brochures/Seaboard%20Zip%20Pac%20 Manifold%20Systems%20Brochure.pdf [retrieved on 2019-03-20] Seaboard Zip Pac FS -----	2
E	WO 2019/010463 A1 (SEABOARD INT INC [US]) 10 January 2019 (2019-01-10) figures 2,5,6,7,9,10 -----	1,2,5-16
A	WO 2017/083647 A1 (CAMERON INT CORP [US]) 18 May 2017 (2017-05-18) figures 3,4,9-13 -----	1-16

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2018/064484

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:
2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying an additional fees, this Authority did not invite payment of additional fees.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

1-16

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- ☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- ☐ No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. claims: 1-16

A frac transfer system where the manifold is disposed on an adjustable skid and corresponding method

2. claims: 17-34

A spacer comprising a body, a bore and ends configured to form metal-to-metal seals and disposed at an angle greater than zero degrees to each other and corresponding frac transfer unit

3. claims: 35-37

A method of assembling a unit flowline using a wedge spacer

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/US2018/064484

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2017275980 A1	28-09-2017	NONE	

WO 2019010463 A1	10-01-2019	US 2019010781 A1	10-01-2019
		WO 2019010463 A1	10-01-2019

WO 2017083647 A1	18-05-2017	CA 3017111 A1	18-05-2017
		US 2017138144 A1	18-05-2017
		WO 2017083647 A1	18-05-2017
