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(54) **Title:** WIRE CUTTING BLOWOUT PREVENTER

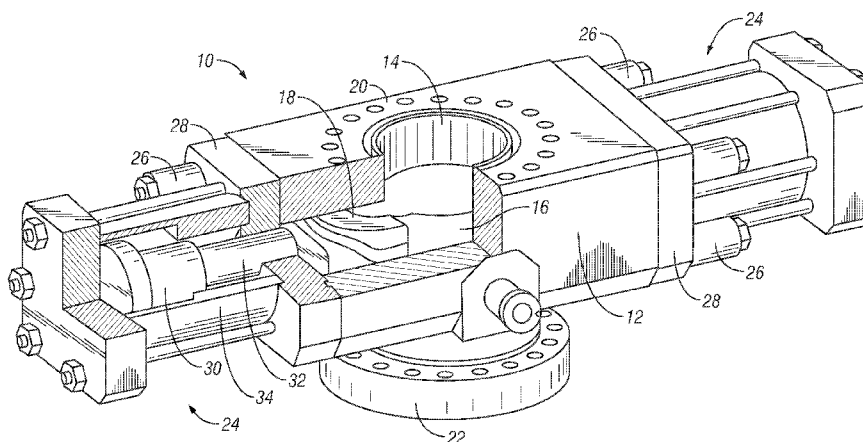


FIG. 1

(57) **Abstract:** An apparatus includes a blowout preventer housing comprising a bore extending therethrough and a cavity intersecting the bore and a wire cutting apparatus with a cutting wire. The wire cutting apparatus is movably positionable within the cavity of the blowout preventer housing and is extendable into the bore of the blowout preventer housing.

WIRE CUTTING BLOWOUT PREVENTER

BACKGROUND

[0001] This section is intended to introduce the reader to various aspects of art that may be related to various aspects of the present invention, which are described and/or claimed below. This discussion is believed to be helpful in providing the reader with background information to facilitate a better understanding of the various aspects of the present invention. Accordingly, it should be understood that these statements are to be read in this light, and not as admissions of prior art.

[0002] Blowout preventers (BOPs) are used extensively throughout the oil and gas industry. Typical blowout preventers are used as a large specialized valve or similar mechanical device that seal, control, and monitor oil and gas wells. The two categories of blowout preventers that are most prevalent are ram blowout preventers and annular blowout preventers. Blowout preventer stacks frequently utilize both types, typically with at least one annular blowout preventer stacked above several ram blowout preventers. The ram units in ram blowout preventers allow for both the shearing of the drill pipe and the sealing of the blowout preventer. A blowout preventer stack may be secured to a wellhead and may provide a safe means for sealing the well in the event of a system failure.

[0003] In a typical ram blowout preventer, a ram bonnet assembly may be bolted to the main body using a number of high tensile bolts or studs. These bolts are required to hold the bonnet in position to enable the sealing arrangements to work effectively. During normal operation, the blowout preventers may be subject to pressures up to 20,000 psi, or even higher. To be able to operate against and to contain fluids at such pressures, blowout preventers are becoming larger and stronger. Blowout preventer stacks, including related devices, 30 feet or more in height are increasingly common. Further, ram-type blowout preventers may require interchangeable parts to be used with pipe having different sizes and strengths. Such requirements, if not impractical, may require the presence of personnel at locations that can be hazardous, and may be limited due to particular size or equipment restrictions.

Brief Description of the Drawings

[0004] For a detailed description of embodiments of the subject disclosure, reference will now be made to the accompanying drawings in which:

[0005] FIG. 1 shows a sectional view of a blowout preventer;

[0006] FIG. 2 shows a wire cutting apparatus for use within a blowout preventer in accordance with one or more embodiments of the present disclosure;

[0007] FIG. 3 shows a side cross-sectional view of a wire cutting apparatus in a retracted position in a blowout preventer in accordance with one or more embodiments of the present disclosure;

[0008] FIG. 4 shows an above schematic view of a wire cutting apparatus in a retracted position in a blowout preventer in accordance with one or more embodiments of the present disclosure;

[0009] FIG. 5 shows a side cross-sectional view of a wire cutting apparatus in an extended position in a blowout preventer in accordance with one or more embodiments of the present disclosure;

[0010] FIG. 6 shows an above schematic view of a wire cutting apparatus in an extended position in a blowout preventer in accordance with one or more embodiments of the present disclosure;

[0011] FIG. 7 shows an above schematic view of a wire cutting apparatus in a push-type configuration to cut a tubular member in accordance with one or more embodiments of the present disclosure; and

[0012] FIG. 8 shows an above schematic view of a wire cutting apparatus in a pull-type configuration to cut a tubular member in accordance with one or more embodiments of the present disclosure.

Detailed Description

[0013] The following discussion is directed to various embodiments of the invention. The drawing figures are not necessarily to scale. Certain features of the embodiments may be shown exaggerated in scale or in somewhat schematic form and some details of conventional elements may not be shown in the interest of clarity and conciseness. The embodiments disclosed should not be interpreted, or otherwise used, as limiting

the scope of the disclosure, including the claims. It is to be fully recognized that the different teachings of the embodiments discussed below may be employed separately or in any suitable combination to produce desired results. In addition, one skilled in the art will understand that the following description has broad application, and the discussion of any embodiment is meant only to be an illustration of that embodiment, and not intended to intimate that the scope of the disclosure, including the claims, is limited to that embodiment.

[0014] Certain terms are used throughout the following description and claims to refer to particular features or components. As one skilled 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 are the same structure or function.

[0015] 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. In addition, the terms “axial” and “axially” generally mean along or parallel to a central axis (e.g., central axis of a body or a port), while the terms “radial” and “radially” generally mean perpendicular to the central axis. For instance, an axial distance refers to a distance measured along or parallel to the central axis, and a radial distance means a distance measured perpendicular to the central axis. The use of “top,” “bottom,” “above,” “below,” and variations of these terms is made for convenience, but does not require any particular orientation of the components.

[0016] Referring now to FIG. 1, a sectional view of a blowout preventer 10 is shown. The blowout preventer 10 includes a housing 12, such as a hollow body, with a bore 14 that enables passage of fluid or a tubular member through the blowout preventer 10. The housing 12 further includes one or more cavities 16, such as cavities 16 opposed from each other with respect to the bore 14, with a ram 18 movably positioned within each cavity 16. The blowout preventer 10 may be coupled to other equipment that facilitates natural resource production. For instance, production equipment or other components may be attached to the top of the blowout preventer

10 using a connection 20 (which may be facilitated in the form of fasteners), and the blowout preventer 10 may be attached to a wellhead or spool using the flange 22 and additional fasteners.

[0017] One or more bonnet assemblies 24 are secured to the housing 12 and include various components that facilitate control of the rams 18 positioned in the blowout preventer 10. The bonnet assemblies 24 are coupled to the housing 12 by using one or more fasteners 26 to secure the bonnets 28 of the bonnet assemblies 24 to the housing 12. The rams 18 are then actuated and moved through the cavities 16, into and out of the bore 14, by operating and moving a piston 30 and a rod 32 coupled thereto within a housing 34 of the bonnet assemblies 24. In operation, a force (e.g., from hydraulic pressure) may be applied to the pistons 30 to drive the rods 32, which in turn drives the rams 18 coupled thereto into the bore 14 of the blowout preventer 10. The rams 18 cooperate with one another when driven together to seal the bore 14 and inhibit flow through the blowout preventer 10. In another embodiment, the rams 18 may be shear rams such that, when driven towards each other, shear a tubular member present within the bore 14 of the housing 12 of the blowout preventer 10.

[0018] Referring now to FIG. 2, a wire cutting apparatus 220 for use within a blowout preventer in accordance with one or more embodiments of the present disclosure is shown. The wire cutting apparatus 220 may be included in a housing of a blowout preventer to cut and shear a tubular member that is positioned within the bore of the blowout preventer. This may involve moving, extending, and retracting the wire cutting apparatus 220 into and out of the bore of the blowout preventer such that the wire cutting apparatus 220 may cut an object (e.g., tubular member) present within the bore of the blowout preventer. The use of a wire cutting apparatus 220 within a blowout preventer may enable the blowout preventer to operating at lower pressures and forces, thereby reducing the size and equipment requirements.

[0019] The wire cutting apparatus 220 in this embodiment includes a cutting wire 222 that is supported by pulleys 224. An example of a cutting wire 222 may include a diamond impregnated wire, though other types of cutting wire may be used without departing from the scope of the present disclosure. A motor 226 may then be coupled to the pulleys 224 to drive the cutting wire 222. The pulleys 224 may include a drive

pulley 224A and one or more support pulleys 224B. The motor 226 may be operatively coupled to the drive pulley 224A to drive the drive pulley 224A and the cutting wire 222 supported by the pulleys 224.

[0020] The wire cutting apparatus 220 may have a frame 228 with the pulleys 224 supported by the frame 228. In particular, one or more axles of the pulleys 224 may be connected to the frame 228 such that the pulleys 224 are rotatably coupled to the frame 228. One or more gears may be used with the wire cutting apparatus 220, such as to control a speed of the cutting wire 222, as desired. For example, as shown, a gearbox 230 may be included with the wire cutting apparatus 220 with the gearbox 230 coupled between the motor 226 and the drive pulley 224A. The gearbox 230 may enable the motor 226 to control the speed at which the drive pulley 224A rotates, and hence, control the speed at which the cutting wire 222 rotates through the wire cutting apparatus 220.

[0021] As discussed above, the motor 226 may be used to drive the pulleys 224 and the cutting wire 222 though the cutting wire 222, the pulleys 224, and the frame 228 move with respect to the motor 226 (e.g., the cutting wire 222 may extend into and out of a bore of a blowout preventer while the motor 226 remains relatively stationary). The wire cutting apparatus 220 may include one or more components or mechanisms to enable this type of movement between the motor 226 and the cutting wire 222. In this embodiment, a telescoping assembly 232 may be used to operatively couple the motor 226 to the pulleys 224, and more specifically the drive pulley 224A. The telescoping assembly 232 may include an inner shaft 234 and an outer shaft 236 (or more shafts as necessary), with the telescoping assembly 232 extending between the motor 226 and the gearbox 230. This may enable the motor 226 to be operatively coupled to and drive the drive pulley 224A through the telescoping assembly 232 and the gearbox 230 as the cutting wire 222, pulleys 224, and the frame 228 move with respect to the motor 226. The present disclosure also contemplates other components, mechanisms, and assemblies included within the scope of the present disclosure that may also be used to enable such movement between the motor and the cutting wire, if necessary.

[0022] The wire cutting apparatus 220, or a blowout preventer including the wire cutting apparatus 220, may include a drive assembly 240 to move, extend, and retract the wire cutting apparatus 220 into and out of the bore of the blowout preventer. In FIG. 2, the drive assembly 240 includes a housing 242 (e.g., such as a bonnet housing of a blowout preventer) with a piston 244 movably positioned within the housing 242. A rod 246 may then be coupled and extend between the piston 244 and the wire cutting apparatus 220, or more particularly the frame 228 of the wire cutting apparatus 220 in this embodiment, to enable the piston 244 to move the wire cutting apparatus 220 within a blowout preventer. For example, pressure (e.g., hydraulic pressure) may be selectively introduced on either side of the piston 244 to selectively move the piston 244, and hence the wire cutting apparatus 220. The present disclosure also contemplates other types of drive assemblies that may be used to move the wire cutting apparatus 220 within a blowout preventer that are included within the scope of the present disclosure.

[0023] In accordance with one or more embodiments, as the wire cutting apparatus 220 may be included within a blowout preventer, and the blowout preventer may be used subsea, the wire cutting apparatus 220 may include multiple sources to power the wire cutting apparatus 220. For example, as shown in FIG. 2, a remotely-operated vehicle (ROV) drive coupling 238 may be included with the wire cutting apparatus 220. In this embodiment, the ROV drive coupling 238 may be operatively coupled to the motor 226 to enable an ROV to supplement or provide power to the motor 226. This may enable additional or alternative power sources to drive the cutting wire 222 of the wire cutting apparatus 220. Accordingly, in one or more embodiments, the wire cutting apparatus 220 may be able to operate independent of a blowout preventer control system, without power from the surface of the blowout preventer control system, and/or electrical power. In one or more such embodiments, the wire cutting apparatus 220 may not include electrical components or electronics.

[0024] Referring now to FIGS. 3–6, a blowout preventer 300 including a wire cutting apparatus 320 in accordance with one or more embodiments of the present disclosure is shown. FIG. 3 shows a side cross-sectional view of the blowout preventer 300 in a retracted position, and FIG. 4 shows an above view of the blowout

preventer 300 in the retracted position. Further, FIG. 5 shows a side cross-sectional view of the blowout preventer 300 in an extended position, and FIG. 6 shows an above view of the blowout preventer 300 in the extended position.

[0025] The blowout preventer 300 includes a housing 302, in which the housing 302 includes a bore 304 extending through the housing 302 and one or more cavities 306 in the housing 302 that intersect with the bore 304. The wire cutting apparatus 320 may be movably positioned within the housing 302, such as within the cavity 306, of the blowout preventer 300. The wire cutting apparatus 320 may then move (e.g., extend and retract) into and out of the bore 304 of the housing 302 of the blowout preventer 300. As such, if an object, such as a tubular member 308, is included within the bore 304 of the blowout preventer 300, the wire cutting apparatus 320 may be used to cut or shear the tubular member 308.

[0026] As discussed above, the wire cutting apparatus 320 includes a wire 322 supported by pulleys 324 with a motor 326 to drive the cutting wire 322 using the pulleys 324. The wire cutting apparatus 320 may have a frame 328 with the pulleys 324 supported by the frame 328, and a gearbox 330 may be coupled between the motor 326 and the pulleys 324 to enable the motor 226 to control the speed at which the pulleys 324 (e.g., drive pulley 324A) rotates, and hence, control the speed at which the cutting wire 322 rotate through the wire cutting apparatus 320.

[0027] To facilitate the cutting motion of the wire cutting apparatus 320 within the blowout preventer 300, one or more components, such as a support block 350, may be included to support the object (e.g., tubular member 308) included within the bore 304 of the blowout preventer 300. The support block 350 is shown as positioned opposite the wire cutting apparatus 320 with respect to the bore 304 of the housing 302 of the blowout preventer 300. In one or more embodiments, the support block 350 may be movably positioned within the housing 302, such as within a cavity 306, of the blowout preventer 300. The support block 350 may then move (e.g., extend and retract) into and out of the bore 304 of the housing 302 of the blowout preventer 300. In particular, the support block 350 may extend and retract into and out of the bore 304 along with the wire cutting apparatus 320.

[0028] As shown, the support block 350 may include in this embodiment a concave-profiled face to facilitate supporting the tubular member 308 by the support block 350. In this embodiment, the support block 350 is shown as including a “V” profiled type face 352 such that this profile centralizes and/or stabilizes the tubular member 308 against the support block 350. Further, the support block 350 may include an opening 354 or channel formed therein. This opening 354 may then enable the wire cutting apparatus 320 to be received, at least partially, within and correspond to the support block 350, as shown particularly in FIG. 5, to enable the wire cutting apparatus 320 to fully cut across the tubular member 308.

[0029] As discussed above, the wire cutting apparatus 320, or the blowout preventer 300 including the wire cutting apparatus 320, may include a drive assembly 340 to move, extend, and retract the wire cutting apparatus 320 into and out of the bore 304 of the blowout preventer 300. In this embodiment, the drive assembly 340 includes a housing 342 with a piston 344 movably positioned within the housing 342, and a rod 346 coupled and extending between the piston 344 and the wire cutting apparatus 320.

[0030] Similarly, the support block 350, or the blowout preventer 300 including the support block 350, may include a drive assembly 360 to move, extend, and retract the support block 350 into and out of the bore 304 of the blowout preventer 300. In FIGS. 3–6, the drive assembly 360 includes a housing 362 (e.g., such as a bonnet housing of the blowout preventer 300) with a piston 364 movably positioned within the housing 362. A rod 366 may then be coupled and extend between the piston 364 and the support block 350 to enable the piston 364 to move the support block 350 within the blowout preventer 300.

[0031] In one embodiment, as the support block 350 may extend and retract into and out of the bore 304 along with the wire cutting apparatus 320, the drive assembly 360 of the support block 350 and the drive assembly 340 of the wire cutting apparatus 320 may be linked to each other, in operation with each other, and/or on the same drive circuit to similarly control the movements of the support block 350 and the wire cutting apparatus 320. For example, in the embodiment shown here, the hydraulic pressure used to drive the drive assembly 360 may also be used to drive the drive assembly 340. Further, the present disclosure also contemplates other types of drive

assemblies that may be used to move the support block 350 within a blowout preventer that are included within the scope of the present disclosure.

[0032] In one or more embodiments, a wire cutting apparatus may include a tensioning mechanism, such as to maintain a predetermined tension upon the cutting wire. For example, a tensioning mechanism may involve selectively controlling movement of one or more pulleys with respect to each other to maintain a predetermined tension upon the cutting wire across the pulleys. This may facilitate keeping the cutting wire taut, particularly when cutting an object with the cutting wire.

[0033] Further, in one or more embodiments, the wire cutting apparatus and/or the support block may be movable at or with a predetermined constant force within the blowout preventer. For example, when the wire cutting apparatus 320 and the support block 350 are extending into the bore 304 of the blowout preventer 300 to cut the tubular member 308, the movement of the wire cutting apparatus 320 and/or the support block 350 may be controlled to apply a predetermined constant force upon the tubular member 308. This may facilitate the cutting motion of the wire cutting apparatus 320 and prevent potential jamming or stalling of the wire cutting apparatus 320.

[0034] Furthermore, in one or more embodiments, the wire cutting apparatus and/or the support block may be protected, such as from contents included within the bore of the blowout preventer, when not in use and positioned within the bore of the blowout preventer. For example, a flap may be used to cover and/or seal the opening through which the wire cutting apparatus 320 and/or the support block 350 protrude when extending into the bore 304 of the blowout preventer 300. The flap may enable the wire cutting apparatus 320 and/or the support block 350 to extend into the bore 304 of the blowout preventer 300, such as by having the flap rotate out of the way. The flap may then rotate back to protect the openings and prevent content from the bore 304 flowing back into the cavities 306 of the blowout preventer 300. The flap may be biased to close over the openings and then may move out of the way of the wire cutting apparatus 320 and/or the support block 350 when engaged. Alternatively, the

flap may be separately controlled to move as the wire cutting apparatus 320 and/or the support block 350 move into and out of the bore 304 of the blowout preventer 300.

[0035] In one or more embodiments, the wire cutting apparatus and/or the support block may be used to seal the bore of the blowout preventer. For example, after the tubular member 308 is cut with the wire cutting apparatus 320, the support block 350 may move and extend across the bore 304. By extending out and across the bore 304, the support block 350 may be able to seal the bore 304, such as to prevent fluid from passing through the bore 304 after the tubular member 308 is cut. This may enable the blowout preventer 300 to not only be capable of shearing the tubular member 308 positioned therein, but also capable of sealing the bore 304 within the blowout preventer 300 after the tubular member 308 has been cut.

[0036] Referring now to FIGS. 7 and 8, multiple schematic above views of a wire cutting apparatus 720 to cut a tubular member 708 in accordance with one or more embodiments of the present disclosure are shown. In particular, FIG. 7 shows an embodiment of the wire cutting apparatus 720 in a push-type configuration to cut the tubular member 708, and FIG. 8 shows an embodiment of the wire cutting apparatus 720 in a pull-type configuration to cut the tubular member 708.

[0037] As with the above, the wire cutting apparatus 720 may include a wire 722 supported by pulleys 724 with a motor 726 to drive the cutting wire 722 using the pulleys 724. A gearbox 730 may be coupled between the motor 726 and the drive pulley 724A to control the speed at which the cutting wire 722 rotates through the wire cutting apparatus 720. Further, a telescoping assembly 732 including an inner shaft 734 and an outer shaft 736 (or more shafts as necessary) may extend between the motor 726 and the gearbox 730.

[0038] In the above embodiments, and in FIG. 7, the wire cutting apparatus 720 may be used in the push-type configuration to cut the tubular member 708, in which the wire cutting apparatus 720 is pushed (e.g., extended) into the bore of the blowout preventer to contact and cut the tubular member 708. In another embodiment, and in FIG. 8, the wire cutting apparatus 720 may be used in the pull-type configuration to cut the tubular member 708, in which the wire cutting apparatus 720 is pulled (e.g., retracted) from or out of the bore of the blowout preventer to contact and cut the

tubular member 708. In such an embodiment, the cutting wire 722 may be positioned within the bore of the blowout preventer to have the tubular member 708 received into a loop formed by the cutting wire 722. Then, once desired, the wire cutting apparatus 720 may be retracted out of the bore of the blowout preventer to have the cutting wire 722 contact and cut the tubular member 708. Accordingly, a blowout preventer in accordance with the present disclosure may employ either of these types of configurations without departing from the scope of the present disclosure.

[0039] As mentioned above, a blowout preventer in accordance with the present disclosure may be able to operate at lower pressures and with lower forces, such as due to the use of a wire cutting apparatus. This may reduce the size and equipment requirements necessary for the use of a blowout preventer, in particular in a subsea environment where higher pressures and higher forces are often necessary for the shearing of tubular members.

[0040] Although the present invention has been described with respect to specific details, it is not intended that such details should be regarded as limitations on the scope of the invention, except to the extent that they are included in the accompanying claims.

Claims

What is claimed is:

1. An apparatus, comprising:
a blowout preventer housing comprising a bore extending therethrough and a cavity intersecting the bore; and
a wire cutting apparatus comprising a cutting wire with the wire cutting apparatus movably positionable within the cavity of the blowout preventer housing and extendable into the bore of the blowout preventer housing.
2. The apparatus of claim 1, wherein the wire cutting apparatus comprises:
pulleys to support the cutting wire; and
a motor to drive the cutting wire using the pulleys;
wherein the cutting wire is configured to cut a tubular member positioned within the bore of the blowout preventer housing.
3. The apparatus of claim 2, wherein the wire cutting apparatus further comprises:
a frame with the pulleys supported by the frame, the pulleys including a drive pulley and a support pulley, wherein the motor is configured to drive the drive pulley; and
a gearbox located between the drive pulley and the motor to control a speed of the cutting wire.
4. The apparatus of claim 3, wherein the wire cutting apparatus further comprises a telescoping assembly to operatively couple the motor to the drive pulley.
5. The apparatus of claim 2, wherein the wire cutting apparatus further comprises a tensioning mechanism to maintain a predetermined tension upon the cutting wire across the pulleys.
6. The apparatus of claim 2, wherein the cutting wire comprises diamond impregnated wire.

7. The apparatus of claim 2, wherein the motor comprises an ROV drive coupling for an ROV to provide power to the motor.
8. The apparatus of claim 1, wherein the wire cutting apparatus is extendable into the bore of the blowout preventer housing at a predetermined constant force.
9. The apparatus of claim 1, further comprising a flap to protect the wire cutting apparatus within the cavity of the blowout preventer housing from contents within the bore of the blowout preventer housing.
10. The apparatus of claim 1, further comprising:
 - a support block positioned opposite the wire cutting apparatus with respect to the bore of the blowout preventer housing; and
 - the support block movably positionable within the cavity of the blowout preventer housing and extendable into the bore of the blowout preventer housing.
11. The apparatus of claim 1, further comprising:
 - a bonnet housing coupleable to the blowout prevent housing;
 - a piston movably positionable within the bonnet housing; and
 - a rod coupleable between the wire cutting apparatus and the piston such that movement of the piston moves the wire cutting apparatus within the blowout preventer housing.
12. An apparatus, comprising:
 - a blowout preventer housing comprising a bore extending through the blowout preventer housing;
 - a wire cutting apparatus comprising a cutting wire with the wire cutting apparatus movably positionable within the blowout preventer housing and extendable into the bore of the blowout preventer housing; and
 - a wire cutting apparatus drive assembly to move the wire cutting apparatus within the blowout preventer housing.

13. The apparatus of claim 12, wherein the wire cutting apparatus drive assembly comprises:

- a housing;
- a piston movably positionable within the housing;
- a rod coupleable between the wire cutting apparatus and the piston such that movement of the piston moves the wire cutting apparatus within the blowout preventer housing.

14. The apparatus of claim 12, further comprising:

- a support block movably positionable within the blowout preventer housing and extendable into the bore of the blowout preventer housing; and
- a support block drive assembly to move the support block within the blowout preventer housing.

15. The apparatus of claim 14, wherein the support block positioned opposite the wire cutting apparatus with respect to the bore of the blowout preventer housing.

16. The apparatus of claim 12, wherein the wire cutting apparatus comprises:
pulleys to support the cutting wire; and
a motor to drive the cutting wire using the pulleys;
wherein the cutting wire is configured to cut a tubular member positioned
within the bore of the blowout preventer housing.
17. The apparatus of claim 16, wherein the wire cutting apparatus further
comprises:
a frame with the pulleys supported by the frame, the pulleys including a drive
pulley and a support pulley, wherein the motor is configured to drive the
drive pulley; and
a gearbox located between the drive pulley and the motor to control a speed of
the cutting wire.
18. The apparatus of claim 17, wherein the wire cutting apparatus further
comprises a telescoping assembly to operatively couple the motor to the drive pulley.
19. The apparatus of claim 16, wherein the wire cutting apparatus further
comprises a tensioning mechanism to maintain a predetermined tension upon the
cutting wire across the pulleys, and wherein the wire cutting apparatus is extendable
into the bore of the blowout preventer housing at a predetermined constant force.
20. The apparatus of claim 16, wherein the motor comprises an ROV drive
coupling for an ROV to provide power to the motor.

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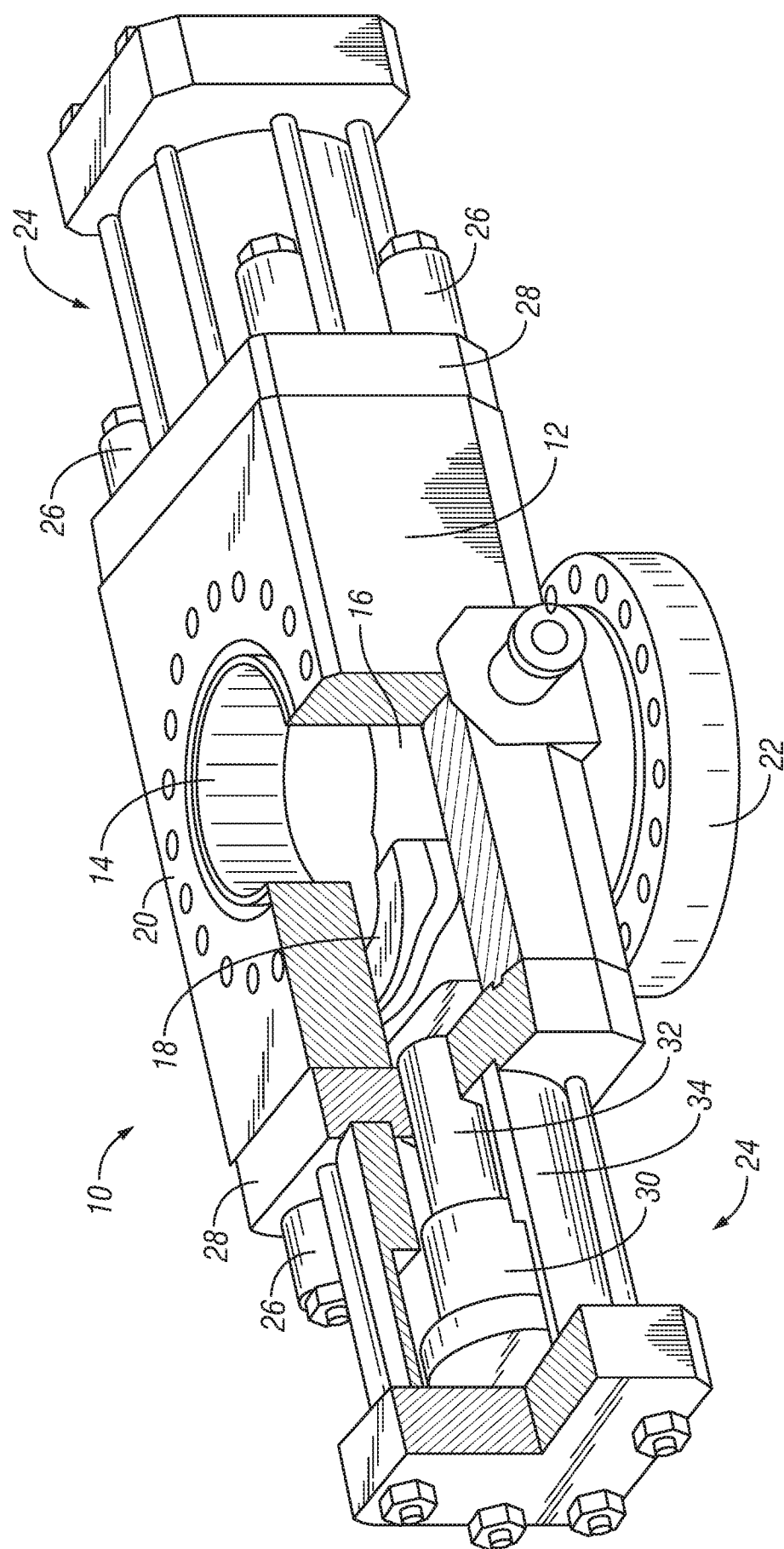


FIG. 1

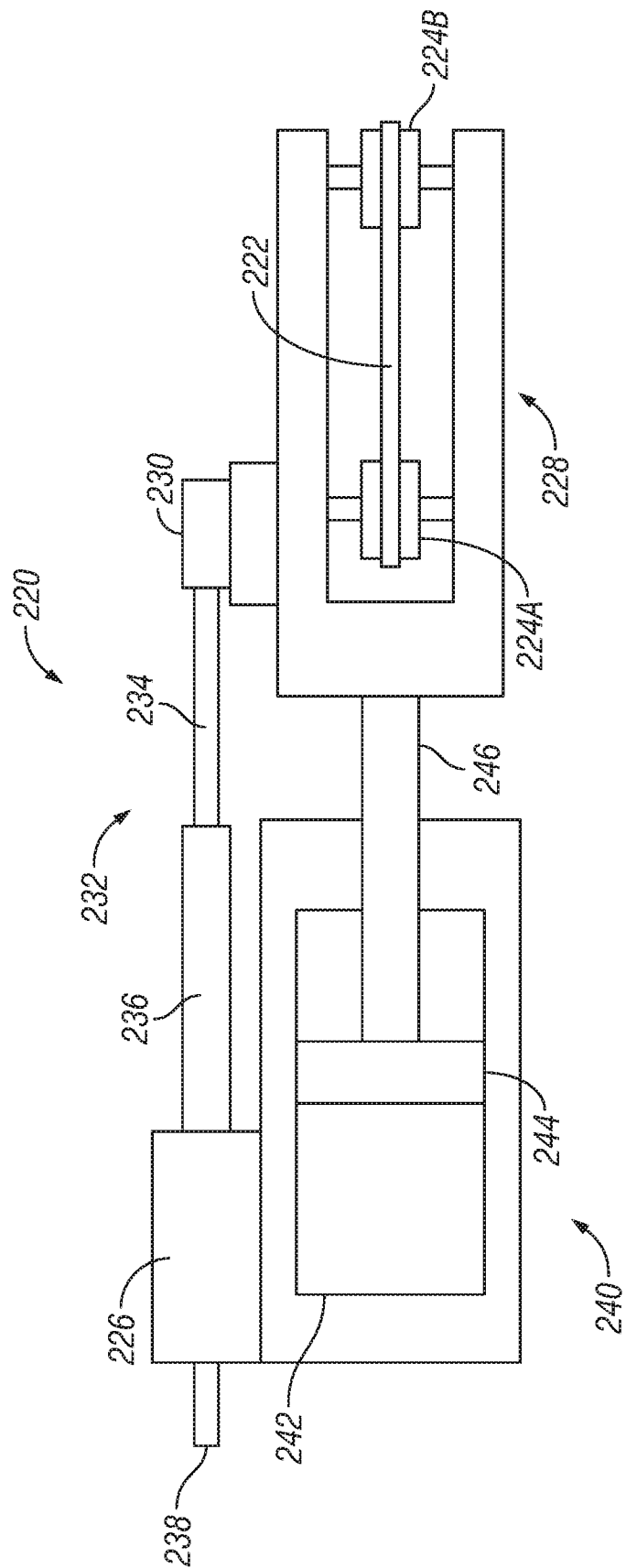
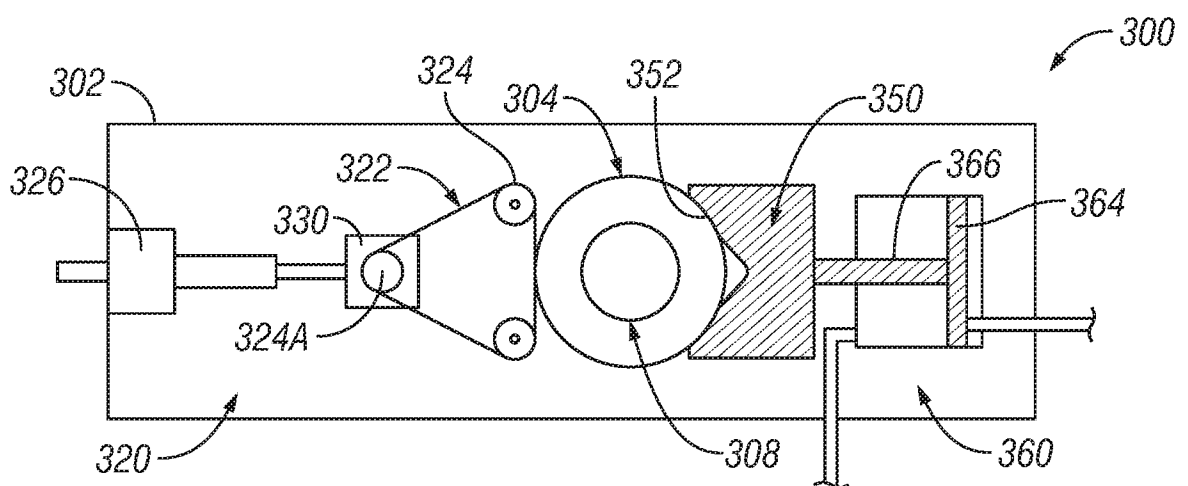
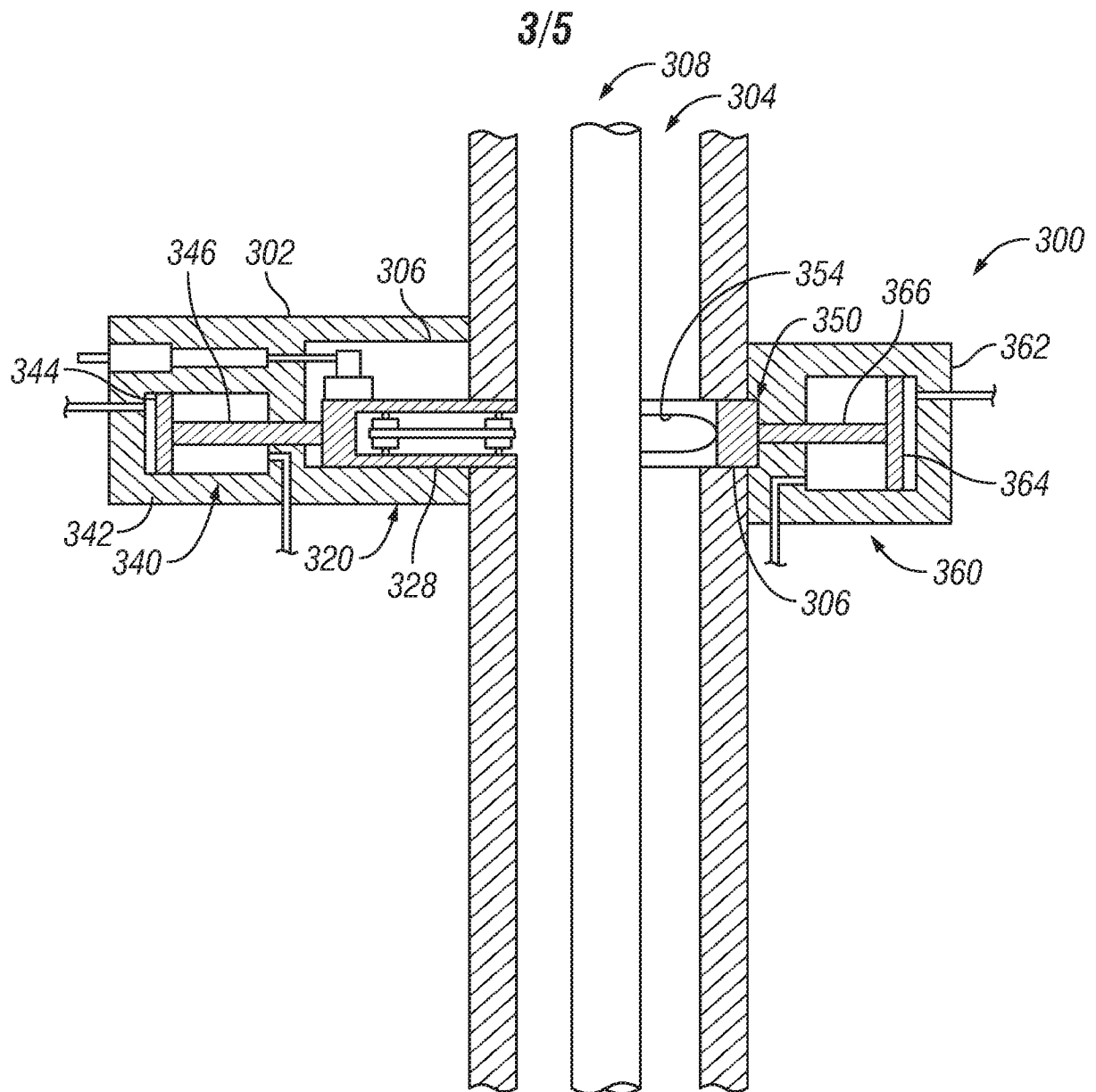


FIG. 2



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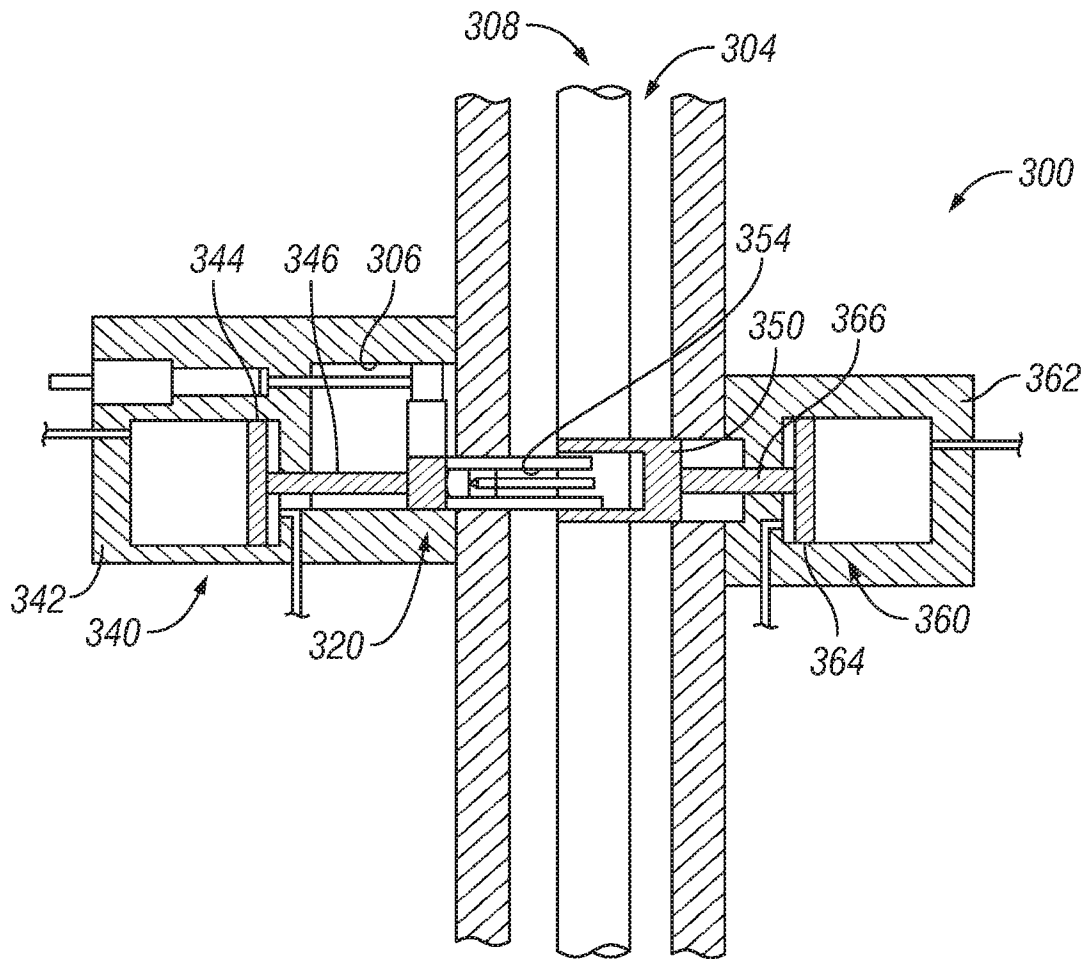


FIG. 5

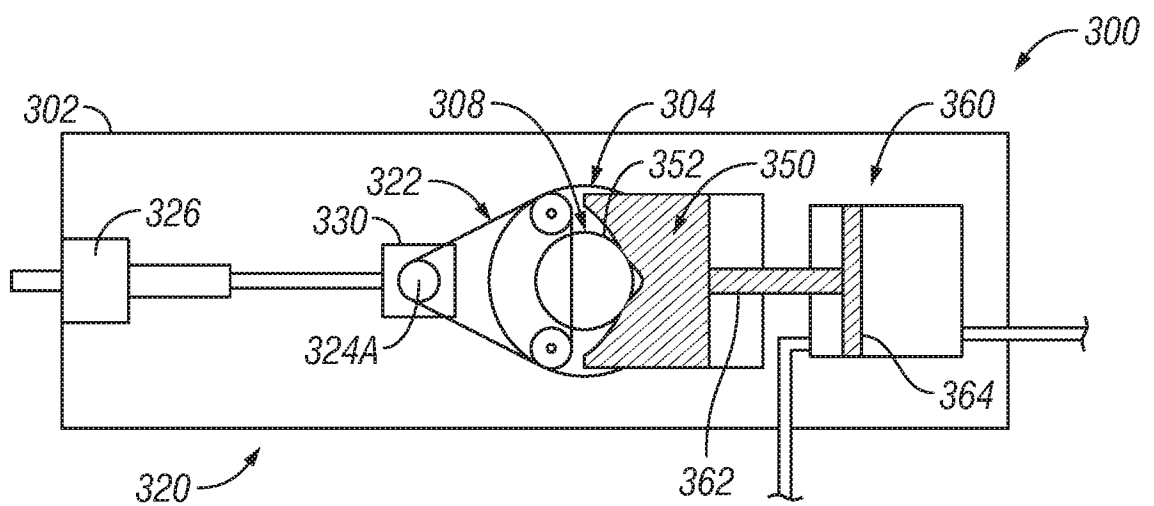


FIG. 6

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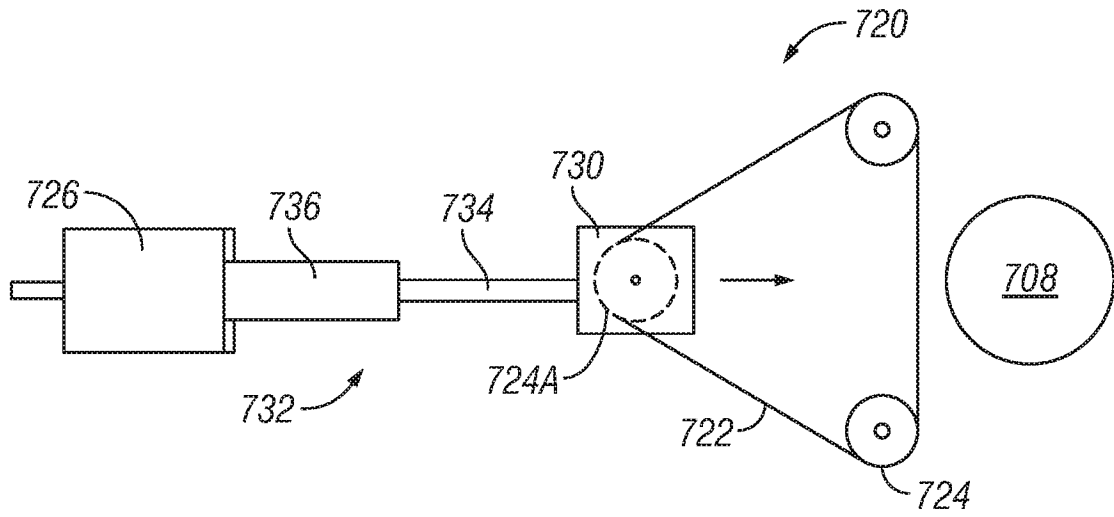


FIG. 7

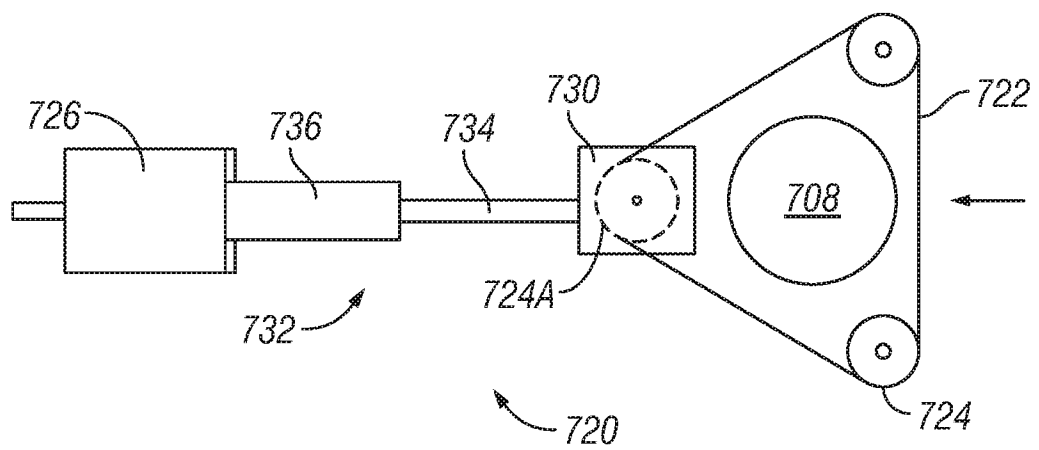


FIG. 8

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2016/028547**A. CLASSIFICATION OF SUBJECT MATTER****E21B 33/03(2006.01)i, E21B 33/06(2006.01)i, E21B 33/068(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)

E21B 33/03; E21B 33/06; B23D 57/00; E21B 33/068; B28D 5/00

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: blowout, preventer, well, cutting, wire, pulley, drive, motor and piston

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2014-0332225 A1 (BIRKELAND, PETTER) 13 November 2014 See paragraphs [0108]-[0110], claim 1 and figures A1-A4.	1-20
Y	EP 2633937 A1 (MEYER BURGER AG.) 04 September 2013 See paragraphs [0005], [0044]-[0048], [0078]-[0096] and figures 1-2, 5.	1-20
A	US 2012-0012339 A1 (WEIR et al.) 19 January 2012 See paragraphs [0032]-[0047] and figures 1-7.	1-20
A	US 2014-0264099 A1 (NATIONAL OILWELL VARCO, L.P.) 18 September 2014 See paragraphs [0030]-[0053] and figures 1-7.	1-20
A	US 2008-0196904 A1 (ANGMAN et al.) 21 August 2008 See paragraphs [0029]-[0040] and figures 1-2.	1-20



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents:

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

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"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

28 July 2016 (28.07.2016)

Date of mailing of the international search report

29 July 2016 (29.07.2016)

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/US2016/028547

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2014-0332225 A1	13/11/2014	AU 2012-256462 A1 AU 2012-256462 B2 CA 2834927 A1 EP 2710218 A1 EP 2710218 A4 NO 20110729 A NO 332669 B1 RU 2013154736 A RU 2570044 C2 SG 194768 A1 US 9341041 B2 WO 2012-158044 A1	28/11/2013 24/09/2015 22/11/2012 26/03/2014 28/10/2015 14/05/2012 03/12/2012 27/06/2015 10/12/2015 30/12/2013 17/05/2016 22/11/2012
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US 2012-0012339 A1	19/01/2012	CA 2806080 A1 GB 2495254 A US 8544538 B2 WO 2012-012192 A1	26/01/2012 03/04/2013 01/10/2013 26/01/2012
US 2014-0264099 A1	18/09/2014	AU 2014-238010 A1 AU 2014-238010 A1 CA 2906933 A1 GB 2530415 A NO 20151224 A SG 11201507529 A US 9249643 B2 WO 2014-149568 A2 WO 2014-149568 A3	08/10/2015 25/09/2014 25/09/2014 23/03/2016 18/09/2015 29/10/2015 02/02/2016 25/09/2014 19/02/2015
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