



- (51) International Patent Classification:
E21B 33/13 (2006.01)
- (21) International Application Number:
PCT/US2013/037599
- (22) International Filing Date:
22 April 2013 (22.04.2013)
- (25) Filing Language: English
- (26) Publication Language: English
- (30) Priority Data:
61/639,949 29 April 2012 (29.04.2012) US
- (71) Applicant: **BAKER HUGHES INCORPORATED**
[US/US]; P.O.Box 4740, Houston, TX 77210-4740 (US).
- (72) Inventors: **LAUREL, David, F.**; 16331 Wytchwood
Circle, Cypress, TX 77429 (US). **BAUGHER, Douglas,
K.**; 3507 Spanish Acorn Lane, Spring, TX 77389 (US).
PATE, Charles, J.; 171 Augusta Circle, Mountain Home,
AR 72653 (US). **KOENIG, Kurt, R.**; 16321 Smith Street,
Houston, TX 77040 (US).
- (74) Agent: **HUNTER, Shawn**; Law Office of Shawn Hunter,
P.O. Box 270110, Houston, TX 77277-0110 (US).
- (81) Designated States (*unless otherwise indicated, for every
kind of national protection available*): AE, AG, AL, AM,

AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY,
BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM,
DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT,
HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP,
KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD,
ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI,
NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU,
RW, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ,
TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA,
ZM, ZW.

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

Declarations under Rule 4.17:

- *as to applicant's entitlement to apply for and be granted a
patent (Rule 4.17(ii))*
- *as to the applicant's entitlement to claim the priority of the
earlier application (Rule 4.17(iii))*

[Continued on next page]

- (54) Title: QUICK CONNECT COUPLING FOR CEMENTING OPERATIONS AND THE LIKE

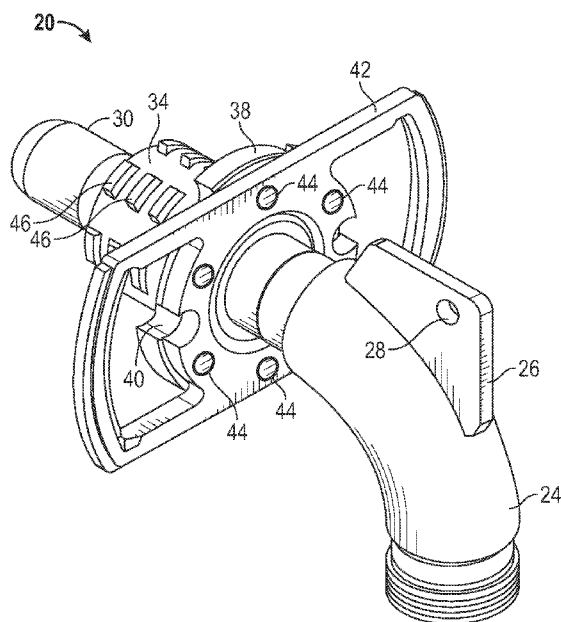


FIG. 2

(57) Abstract: Devices and methods for quickly connecting and disconnecting a conduit to a port. In a described embodiment, a quick connect coupling is described for quickly connecting and disconnecting a cement supply conduit to the port of a top drive cement swivel



Published:

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

QUICK CONNECT COUPLING FOR CEMENTING OPERATIONS AND THE LIKE

[0001] This application claims priority to U.S. Provisional Patent Application serial number 61/639,949 filed April 29, 2012.

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0002] The invention relates generally to cementing equipment used with oilfield wellhead equipment and, in particular aspects, to couplings that are useful for such equipment.

2. Description of the Related Art

[0003] After a hydrocarbon wellbore has been drilled, a casing is typically cemented in along the length of the drilled bore. Cementing equipment is used to do this and typically includes a top drive cement head that permits balls or rubber darts to be dropped into the wellbore during the cementing operation. The cement head also must be capable of flowing cement from a cement supply downwardly into the wellbore. Suitable cementing equipment for these purposes includes a top drive cement head which is available commercially from Baker Hughes Incorporated of Houston, Texas.

SUMMARY OF THE INVENTION

[0004] The invention provides methods and devices for quickly connecting and disconnecting a conduit to a port. In a described embodiment, a quick connect coupling is described for quickly connecting and disconnecting a cement supply conduit to the port of a top drive cement swivel. An exemplary quick connect coupling includes a stinger assembly that is reversibly coupled to a breech lock box

connector on the cement swivel. Raised keys on the breech lock barrel will interfit with complimentary ridges with a bore of the breech lock connector.

[0005] In certain embodiments, a locking arrangement that secures the stinger assembly against rotation within the breech lock connector. In one embodiment, a locking pin is used to lock the stinger assembly into place and against rotation with respect to the cement swivel. An exemplary locking pin is described that is retained by the cement swivel and is axially moveable between unlocked and locked positions. In the locked position, the locking pin will reside within a complimentary indentation within the stinger assembly thereby preventing rotation.

[0006] In operation, a user can quickly and easily couple the stinger assembly with the cement swivel easily and without the need for hammers and other tools to be used. A crane may be used to lift and move the stinger assembly and affixed cement conduit to a position that is proximate the breech lock box connector of the cement swivel. An operator can then orient the stinger assembly so that the keys of the stinger assembly are angularly offset from the ridges within the bore. The stinger and breech lock barrel are then inserted into the bore. Thereafter, the user rotates the stinger assembly to align the keys of the stinger assembly with the ridges of the bore. When aligned, each of the keys are preferably located in line with and behind a ridge, preventing the stinger assembly from being withdrawn from the breech lock connector. The locking arrangement is then engaged to lock the stinger assembly in place so that it cannot be rotated with the breech lock connector.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] The advantages and further aspects of the invention will be readily appreciated by those of ordinary skill in the art as the same becomes better

understood by reference to the following detailed description when considered in conjunction with the accompanying drawings in which like reference characters designate like or similar elements throughout the several figures of the drawing and wherein:

5 **[0008]** Figure 1 is a side view of portions of an exemplary wellbore cementing operation.

[0009] Figure 2 is an isometric view of an exemplary stinger assembly in accordance with the present invention.

[0010] Figure 3 is a side view of the stinger assembly shown in Figure 2.

10 **[0011]** Figure 4 is a cross-sectional view taken along lines 4-4 in Figure 3.

[0012] Figure 5 is a front view of an exemplary cement swivel with stinger assembly attached in accordance with the present invention.

[0013] Figure 6 is a cross-sectional view taken along lines 6-6 in Figure 5.

15 **[0014]** Figure 7 is a front view of the cement swivel and stinger assembly depicting the stinger assembly being coupled to the swivel.

[0015] Figure 8 is an enlarged cross-sectional view of portions of an exemplary coupling in accordance with the present invention.

[0016] Figure 9 is a side view of the exemplary cement swivel and stinger assembly shown in an unlocked condition.

20 **[0017]** Figure 10 is a side view of the cement swivel and stinger assembly of Figure 9, now in a locked condition.

[0018] Figure 11 is a cross-sectional view, partially in phantom, showing portions of the stinger assembly and cement swivel in an unsecured condition.

25 **[0019]** Figure 12 is a cross-sectional view, partially in phantom, showing portions of the stinger assembly and cement swivel now in a secured condition.

[0020] Figure 13 is an isometric view of an exemplary breech lock barrel shown apart from other components of the coupling.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

5 [0021] Figure 1 illustrates portions an exemplary cementing operation for a wellbore. A tubular working string 10 extends downwardly into a wellhead 12. A cementing tool 14 is incorporated into the working string 10 which typically contains balls and/or plugs which are launched into the working string 10 during a cementing operation. A top drive cement swivel 16 is affixed to the upper end of the cementing
10 tool 14. The cement swivel 16 operates to receive cement and transmit it through a flowpath in the cementing tool 14 so that the cement can be flowed downwardly into the working string 10. Figure 1 also depicts a cement hose 18 with an affixed stinger assembly 20. Cement can be flowed to the cement swivel 16 when the stinger assembly 20 is coupled to the cement swivel 16. The cement hose 18 and stinger
15 assembly 20 are depicted being lifted by block and tackle 22.

[0022] The structure and operation of an exemplary stinger assembly 20 are better appreciated with further reference to Figures 2-4. The stinger assembly 20 includes a curved rigid pipe portion 24 that is affixed to the hose 18. A flange 26 with lifting eye 28 extends upwardly from the pipe portion 24. A stinger 30 extends outwardly
20 from the pipe portion 24. A cement flow path 32 is defined within the pipe portion 24 and stinger 30. A breech lock barrel 34 radially surrounds the stinger 30 and, as can be seen best in Figures 4 and 8, secured to the stinger 30 by a sleeve 36 that preferably permits the breech lock barrel 34 to rotate about the stinger 30. Figure 13 shows the breech lock barrel 34 apart from the other components of the stinger
25 assembly 20. A flange 38 projects radially outwardly from the breech lock barrel 34

and presents at least one indentation 40. In the depicted embodiment, there are six indentations 40. In preferred embodiments, an enlarged grippable handle 42 also radially surrounds the stinger 30 and is secured by bolts 44 (Figure 2) to the breech lock barrel 34 so that the stinger 30 will be rotated when the handle 42 is rotated.

5 **[0023]** The outer radial surface of the breech lock barrel 34 preferably presents a plurality of raised keys 46. As will be appreciated with regard to Figs. 2, 3, 4 and 8, the keys 46 are organized into rows (A, B and C) and perpendicular columns. The keys 46 are spaced apart from each other along each of the rows A, B and C and each of the columns. In some embodiments, there are six keys 46 per row A, B and
10 C spaced angularly from each other at about 30 degrees apart. In certain embodiments, the breech lock barrel 34 also includes a row of raised anti-rotation locking dogs 47. In the depicted embodiment, there are six locking dogs 47 that are positioned in a spaced relation from one another of about 30 degrees apart.

[0024] The structure of the exemplary top drive cement swivel 16 is better
15 understood with reference to Figures 5-10. It can be seen that the cement swivel 16 has a generally box-shaped main housing 50. A central axial flowbore 52 passes vertically through the main housing 50. Lateral fluid flow openings 54, 56 extend through the main housing 50 and permit fluid communication between the central flowbore 52 and the exterior of the cement swivel 16. A tubular breech lock box
20 connector 58 extends outwardly from the main housing 50. As illustrated in Figures 11 and 12, the breech lock box connector 58 defines an interior bore 60 having a plurality of inwardly projecting ridges 62. The ridges 62 are spaced apart from each other both radially and axially within the bore 60. Preferably, the interior bore 60 also includes an annular fluid seal 63 (Figure 8) that creates a fluid seal against the
25 stinger 30 when it is inserted into the bore 60. In addition, the interior bore 60 also

presents a row of inwardly projecting anti-rotation locking dogs 48. The dogs 48 are meant to be complimentary to the anti-rotation dogs 47 of the breech lock barrel 34.

[0025] Figures 9 and 10 illustrate a locking pin 64 which is preferably used with the cement swivel 16 and is used to lock the stinger assembly 20 into a coupled position with respect to the cement swivel 16. The locking pin 64 is preferably retained by a sleeve 66 and is axially shiftable between two positions. In the unlocked position shown in Figure 9, the locking pin 64 does not prevent rotation of the stinger assembly 20 with respect to the cement swivel 16. In the locked position shown in Figure 10, the locking pin 64 is disposed within an indentation 40 of the flange 38 and will prevent rotation of the stinger assembly 20 with respect to the cement swivel 16. In particular embodiments, the locking pin 64 has a handle portion 68 that can be used to rotate and shift the locking pin 64 between the unlocked and locked positions.

[0026] In operation, a user can rapidly couple or uncouple the cement conduit 18 to the cement swivel 16. In order to couple the stinger assembly 20 to the cement swivel 16, the block and tackle 22 is used to lift and move the stinger assembly 20 by lifting eye 28 until the stinger assembly 20 is proximate the breech lock connector 58 of the cement swivel 16. A user can then grasp the handle 42 of the stinger assembly 20 and rotate the stinger assembly 20 to the approximate position shown in Figure 7. In Figure 7, the stinger assembly 20 is rotated approximately 30 degrees from the vertical, as illustrated in Figure 7. This rotation will align the keys 46 of the stinger assembly 20 angularly between the ridges 62 of the breech lock barrel bore 60 so that the breech lock barrel 34 can be fully inserted into the bore 60, as illustrated in Figure 11. Once fully inserted, the user will rotate the stinger assembly 20 approximately 30 degrees back to the position depicted in Figure 5.

This rotation will move the raised keys 46 of the breech lock barrel 34 to the position illustrated in Figure 12, wherein each key 46 is located behind a ridge 62 within the bore 60. Also, each row A, B and C of keys 46 is located behind a row of ridges 62. The locking dogs 47 will radially abut the dogs 48 of the bore 60 (as depicted in Figure 12), preventing further rotation beyond 30 degrees. In this position, the stinger assembly 20 cannot be axially withdrawn from the bore 60. The stinger assembly 20 is now coupled to the cement swivel 16. The user can now move the locking pin 64 from the unlocked position (Fig. 9) to the locked position (Fig. 10) as described previously. Seating of the locking pin 64 within the indentation 40 will prevent the stinger assembly 20 from being inadvertently rotated and uncoupled from the cement swivel 16. Cement can now be flowed along the cement flow path 32 from the cement conduit 18 into the lateral flow opening 54 of the cement swivel and into the central flowbore 52 of the cement swivel 16.

[0027] In order to uncouple the stinger assembly 20 from the cement swivel 16, a user will reverse the operations. The locking pin 64 is moved from the locked position (Fig. 10) to the unlocked position (Fig. 9). A user can then rotate the stinger assembly 20 approximately 30 degrees to the position illustrated in Figure 7. The stinger assembly 20 can then be axially withdrawn from the bore 60 of the breech lock connector 58.

[0028] The foregoing description is directed to particular embodiments of the present invention for the purpose of illustration and explanation. It will be apparent, however, to those skilled in the art that many modifications and changes to the embodiment set forth above are possible without departing from the scope and the spirit of the invention.

CLAIMS

What is claimed is:

1

1 1. A coupling for releasably connecting a fluid conduit to a port, the coupling
2 comprising:

3 a stinger assembly affixed to the conduit, the stinger assembly having a
4 generally cylindrical stinger for carrying fluid from the fluid conduit to the port and a
5 generally cylindrical breech lock barrel radially surrounding the stinger and
6 presenting at least one raised key thereupon;

7 a breech lock connector associated with the port, the breech lock connector
8 comprising a bore that is shaped and sized to receive the stinger and the breech lock
9 barrel therein and having at least one radially inwardly projecting ridge and;

10 wherein, the stinger assembly can be secured to the breech lock connector by
11 inserting the stinger assembly within the bore at a rotational angle wherein the at
12 least one key is angularly unaligned with the at least one ridge and then rotating the
13 stinger assembly so that the at least one key is located behind and angularly in line
14 with the at least one ridge.

1

1 2. The coupling of claim 1 further comprising a locking arrangement for securing
2 the stinger assembly against rotation within the breech lock connector.

1

1 3. The coupling of claim 2 wherein the locking arrangement comprises:

2 a locking pin associated with the port that is moveable between a first,
3 unlocked position and a second, locked position; and

4 an indentation associated with the stinger assembly into which the locking pin
5 is seated when in the locked position.

1

1 4. The coupling of claim 1 further comprising a handle that radially surrounds the
2 stinger.

1 5. The coupling of claim 1 wherein there is a plurality of keys and a plurality of
2 ridges.

1 6. The coupling of claim 1 further comprising a lifting eye for lifting the stinger
2 assembly.

1 7. The coupling of claim 1 further comprising:
2 an anti-rotation dog located on the breech lock barrel; and
3 an anti-rotation dog in the interior bore, the anti-rotation dogs of the breech
4 lock barrel and the bore shaped and sized to abut each other radially to limit rotation
5 of the stinger assembly within the interior bore.

1 8. A coupling for releasably connecting a cement conduit to a cement swivel
2 associated with a wellbore cementing tool, the coupling comprising:

3 a stinger assembly affixed to the cement conduit, the stinger assembly having
4 a generally cylindrical stinger for carrying cement from the cement conduit to the
5 cement swivel and a generally cylindrical breech lock barrel radially surrounding the
6 stinger and presenting a plurality raised keys thereupon;

7 a breech lock connector on the cement swivel, the breech lock connector
8 comprising a bore that is shaped and sized to receive the stinger and the breech lock
9 barrel therein and having a plurality of inwardly projecting ridges and;

10 wherein, the stinger assembly can be secured to the breech lock connector by
11 inserting the stinger assembly within the bore at a rotational angle wherein the keys
12 are angularly unaligned with the ridges and then rotating the stinger assembly so

that the keys are each located behind and angularly in line with a ridge.

9. The coupling of claim 8 further comprising a locking arrangement for securing the stinger assembly against rotation within the breech lock connector.

10. The coupling of claim 8 wherein the locking arrangement comprises:
a locking pin associated with the port that is moveable between a first, unlocked position and a second, locked position; and
an indentation associated with the stinger assembly into which the locking pin is seated when in the locked position.

11. The coupling of claim 8 further comprising a handle that radially surrounds the stinger.

12. The coupling of claim 8 further comprising a lifting eye for lifting the stinger assembly.

13. The coupling of claim 8 further comprising:
an anti-rotation dog located on the breech lock barrel; and
an anti-rotation dog in the interior bore, the anti-rotation dogs of the breech lock barrel and the bore shaped and sized to abut each other radially to limit rotation of the stinger assembly within the interior bore.

14. A method for releasably coupling a cement conduit stinger assembly to a bore within a cement swivel associated with a wellbore cementing tool, the method comprising the steps of:

moving the stinger assembly proximate a bore within the cement swivel, the

5 stinger assembly having a stinger with a breech lock barrel that presents a radially
6 outwardly projecting key;

7 orienting the stinger assembly so that the key is angularly unaligned with an
8 inwardly-projecting ridge within the bore;

9 axially moving the stinger and breech lock barrel of the stinger assembly into
10 the bore; and

11 rotating the stinger assembly so that the key is angularly aligned behind the
12 ridge, preventing the stinger assembly from being withdrawn from the bore.

1

1 15. The method of claim 14 further comprising locking the stinger assembly
2 against rotation with respect to the cement swivel.

1

1 16. The method of claim 15 wherein the step of locking the stinger assembly
2 comprises moving a locking pin associated with the cement swivel into seated
3 engagement within an indentation on the stinger assembly.

1

1

1

1

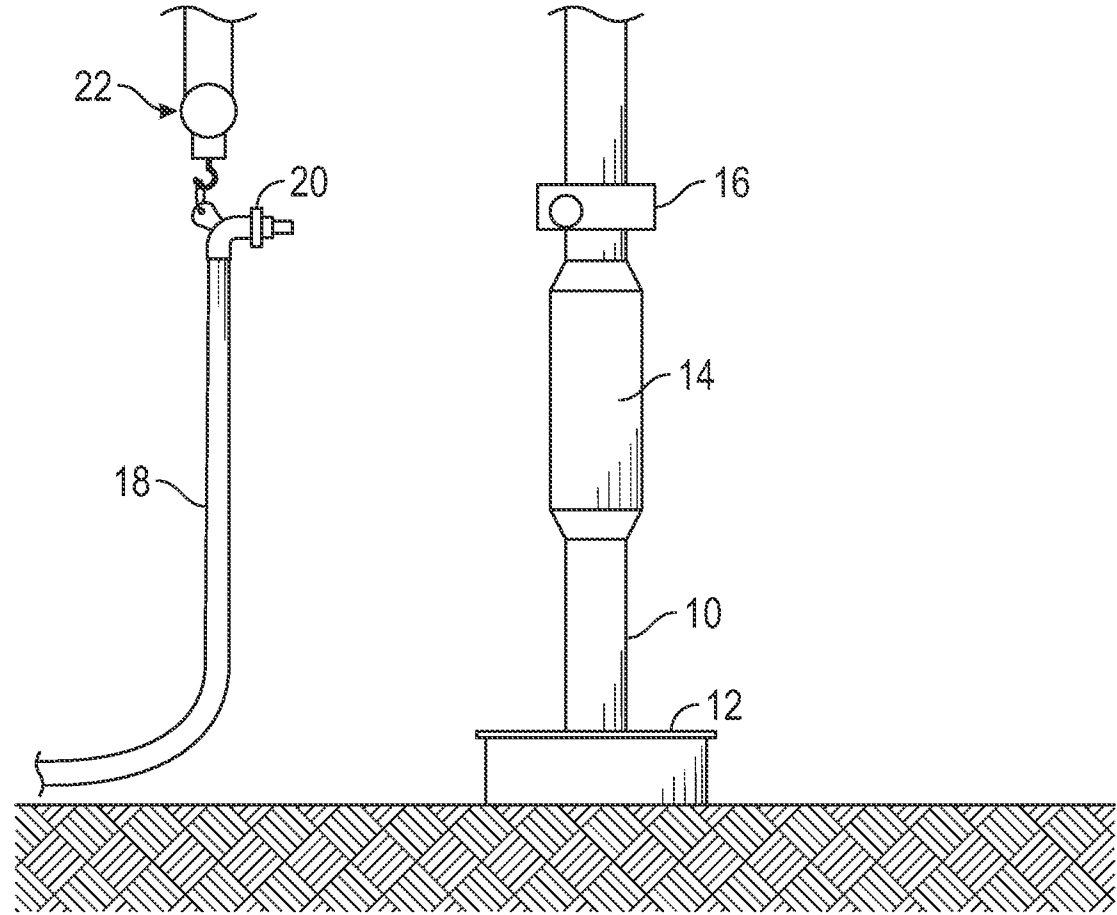


FIG. 1

2/11

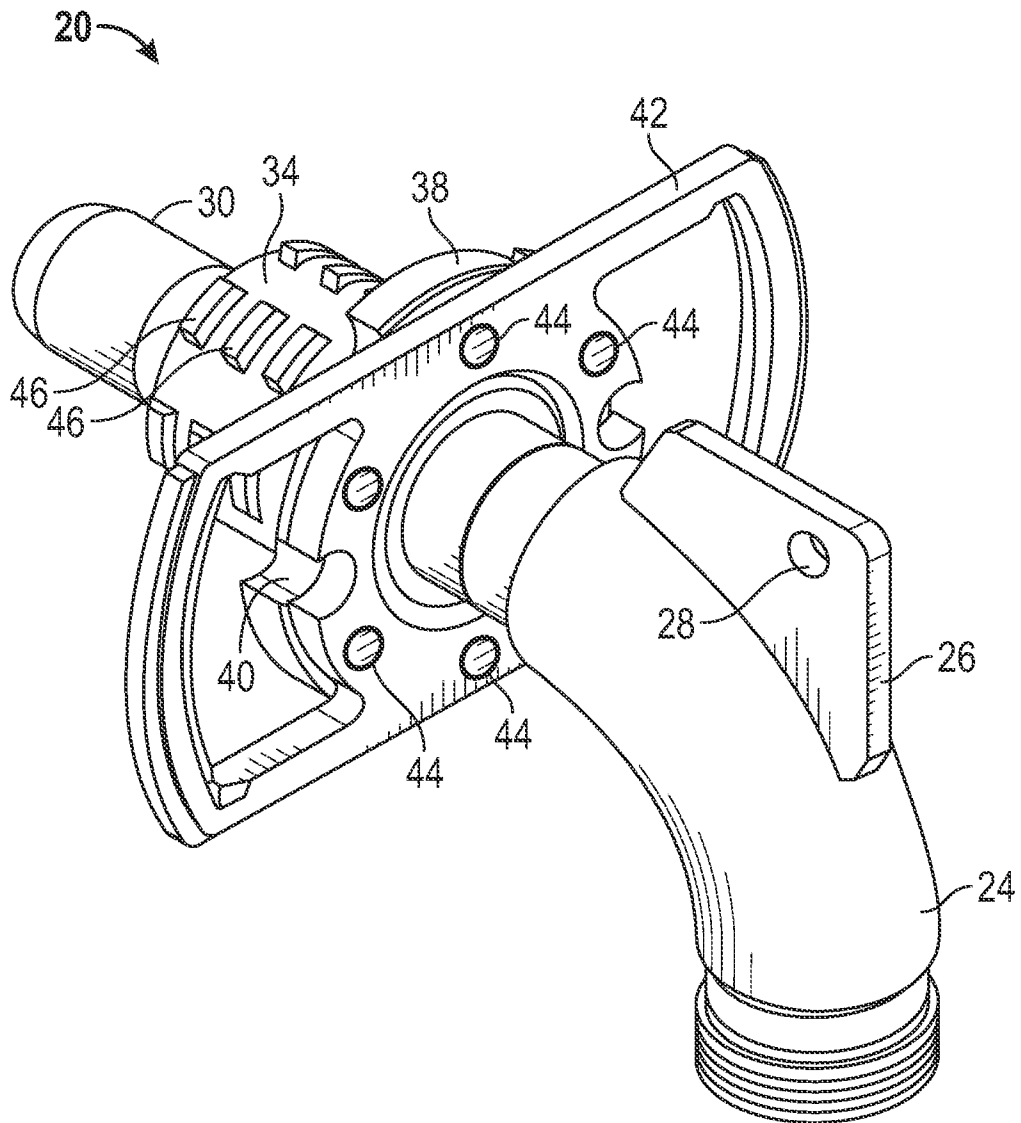
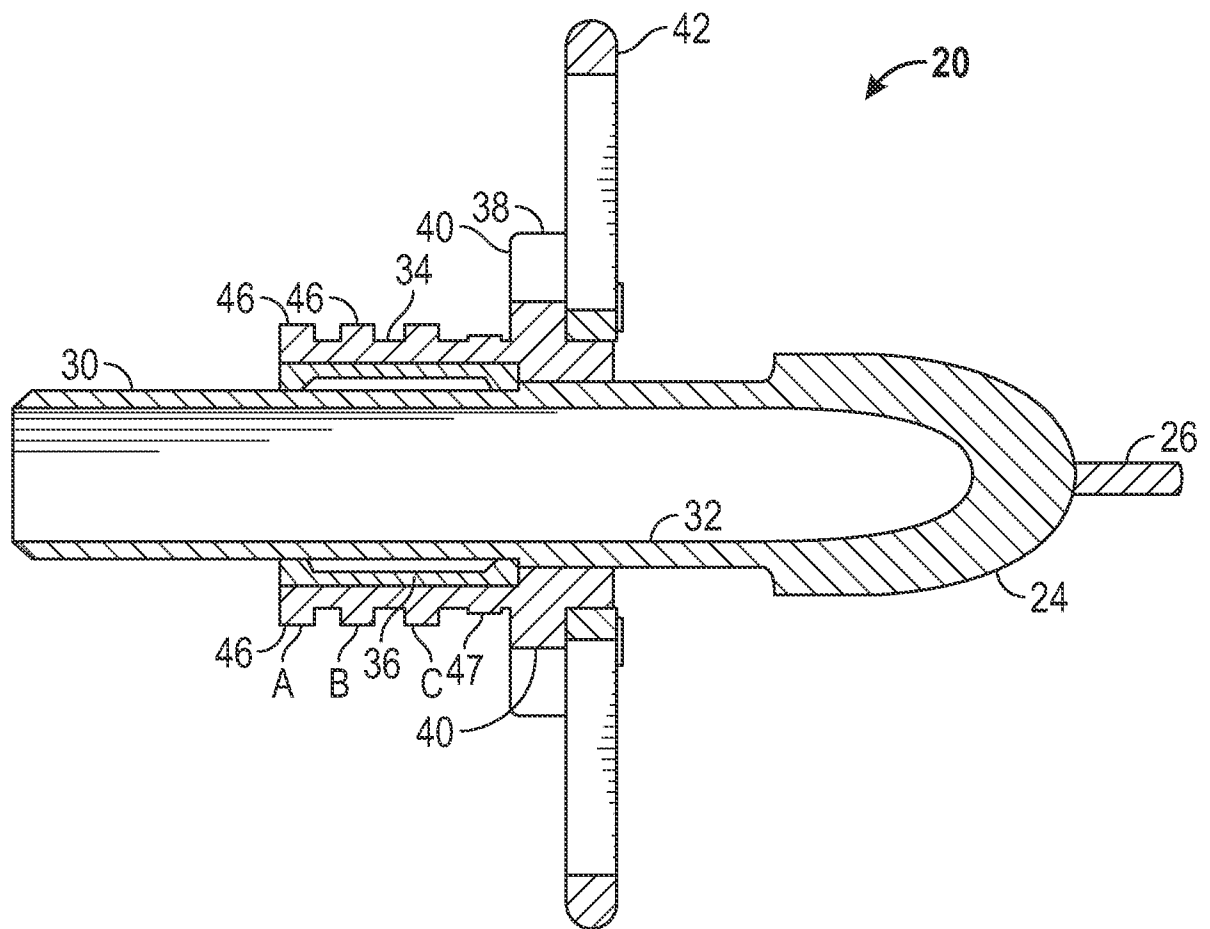
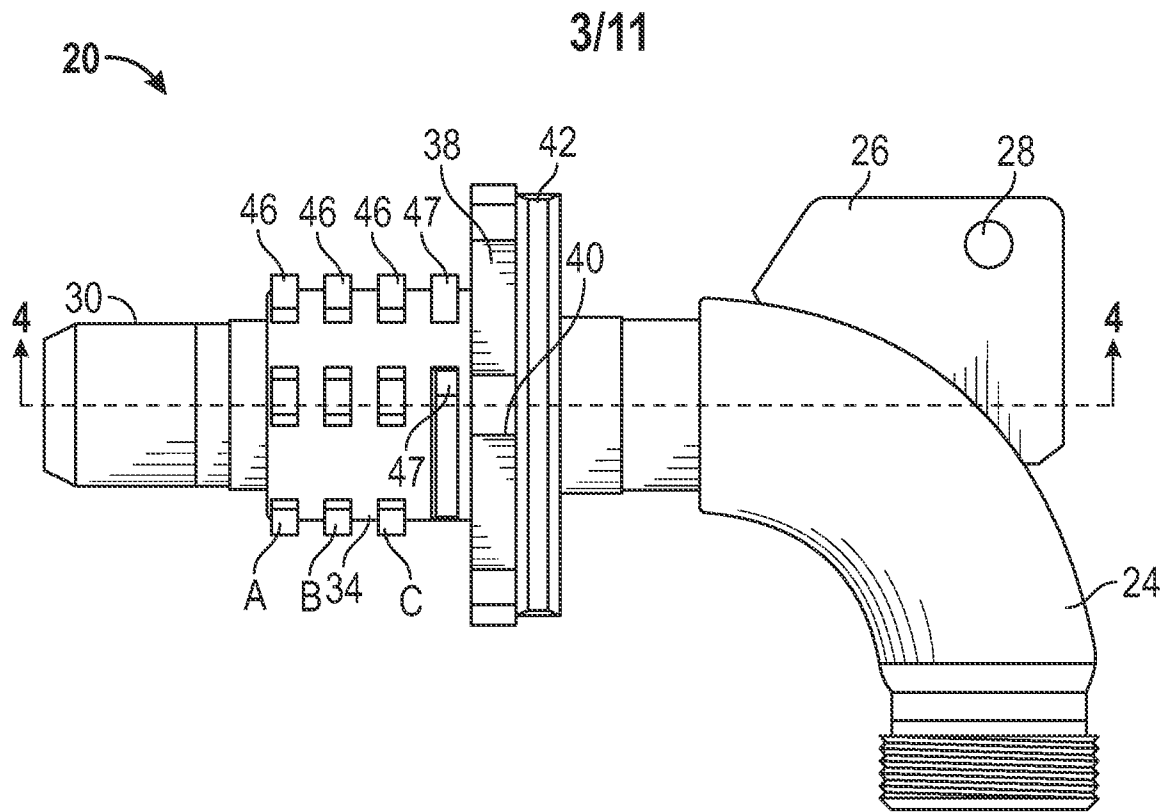
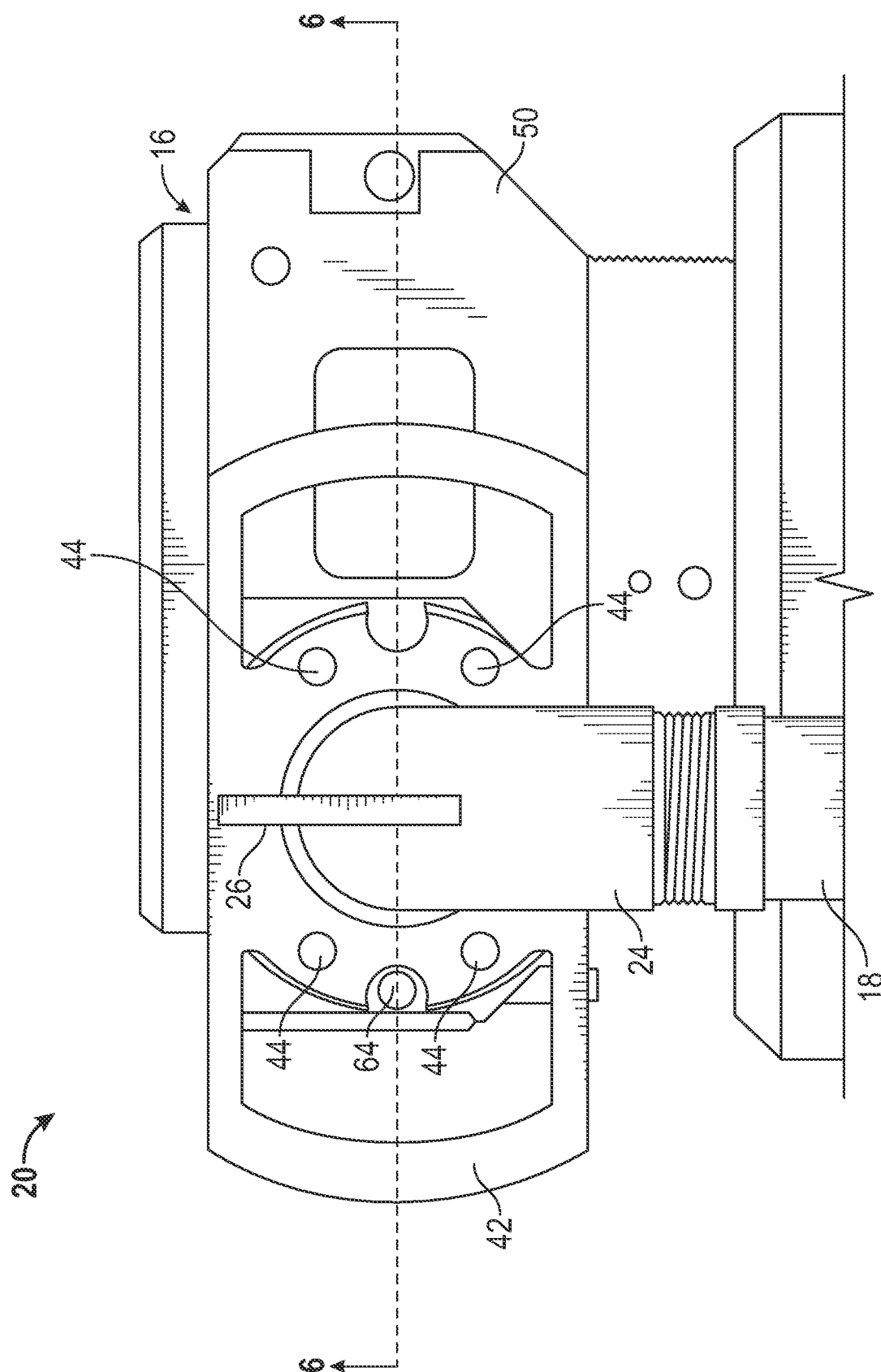


FIG. 2





5/11

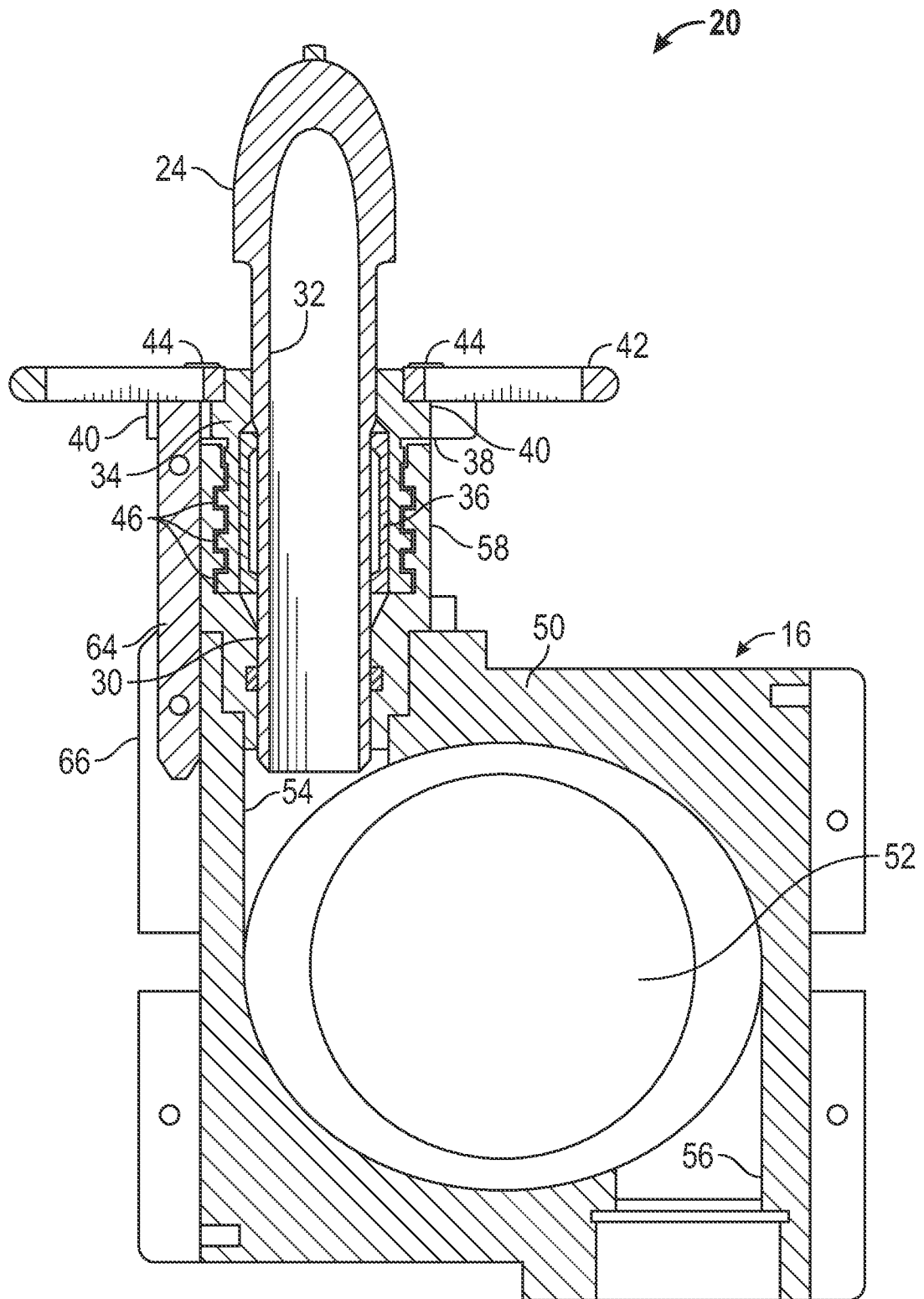
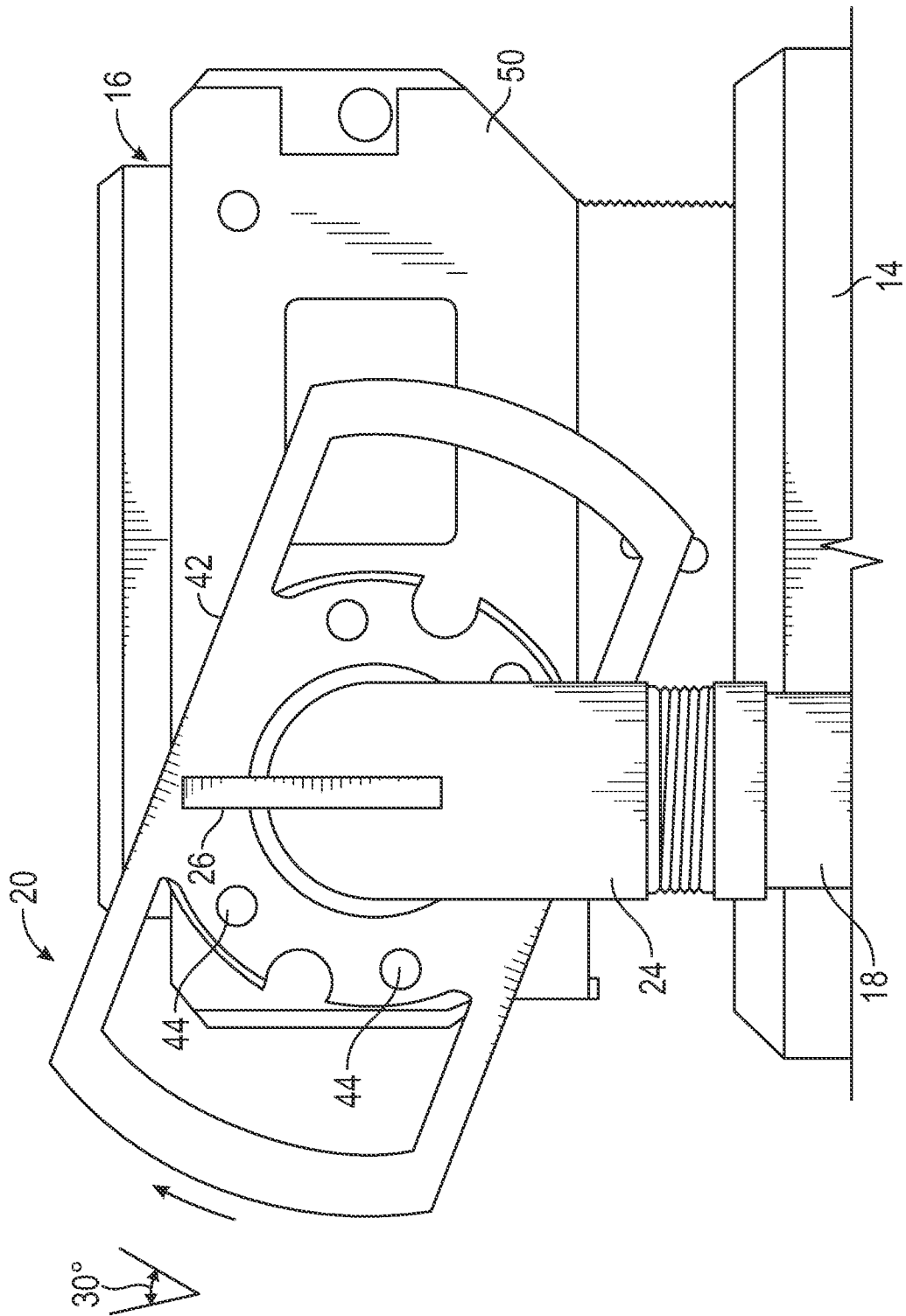


FIG. 6



7/11

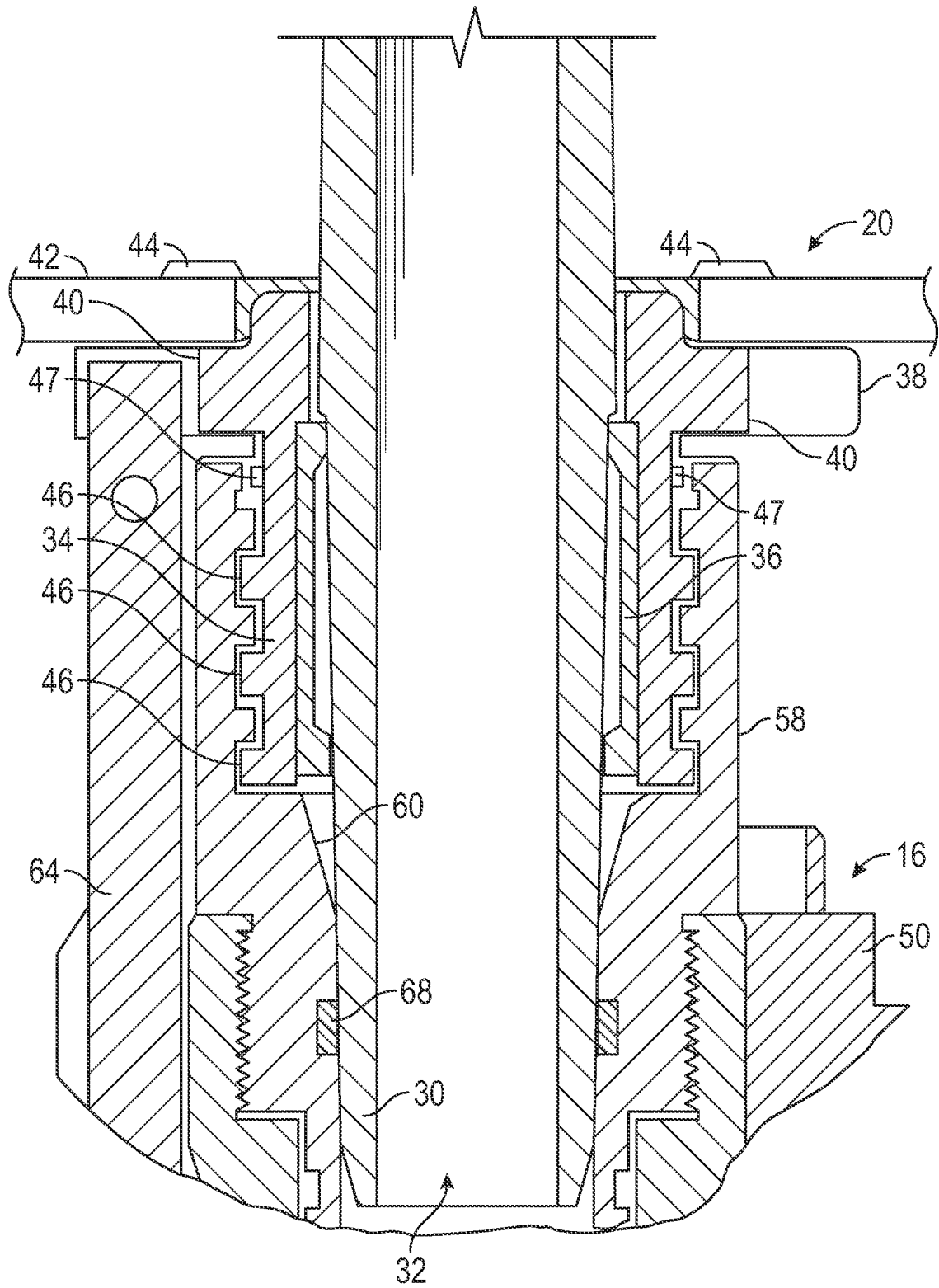


FIG. 8

8/11

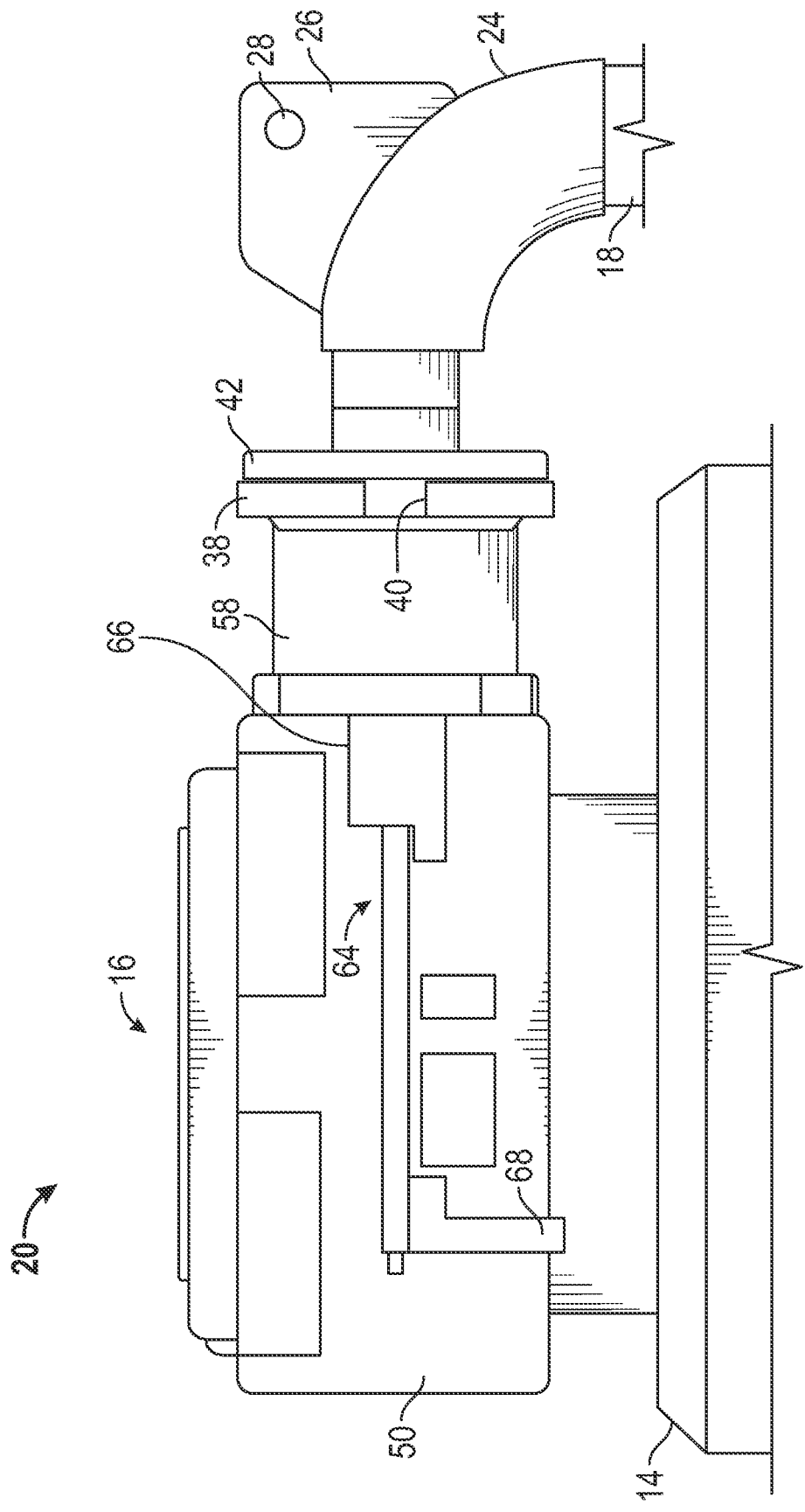


FIG. 9

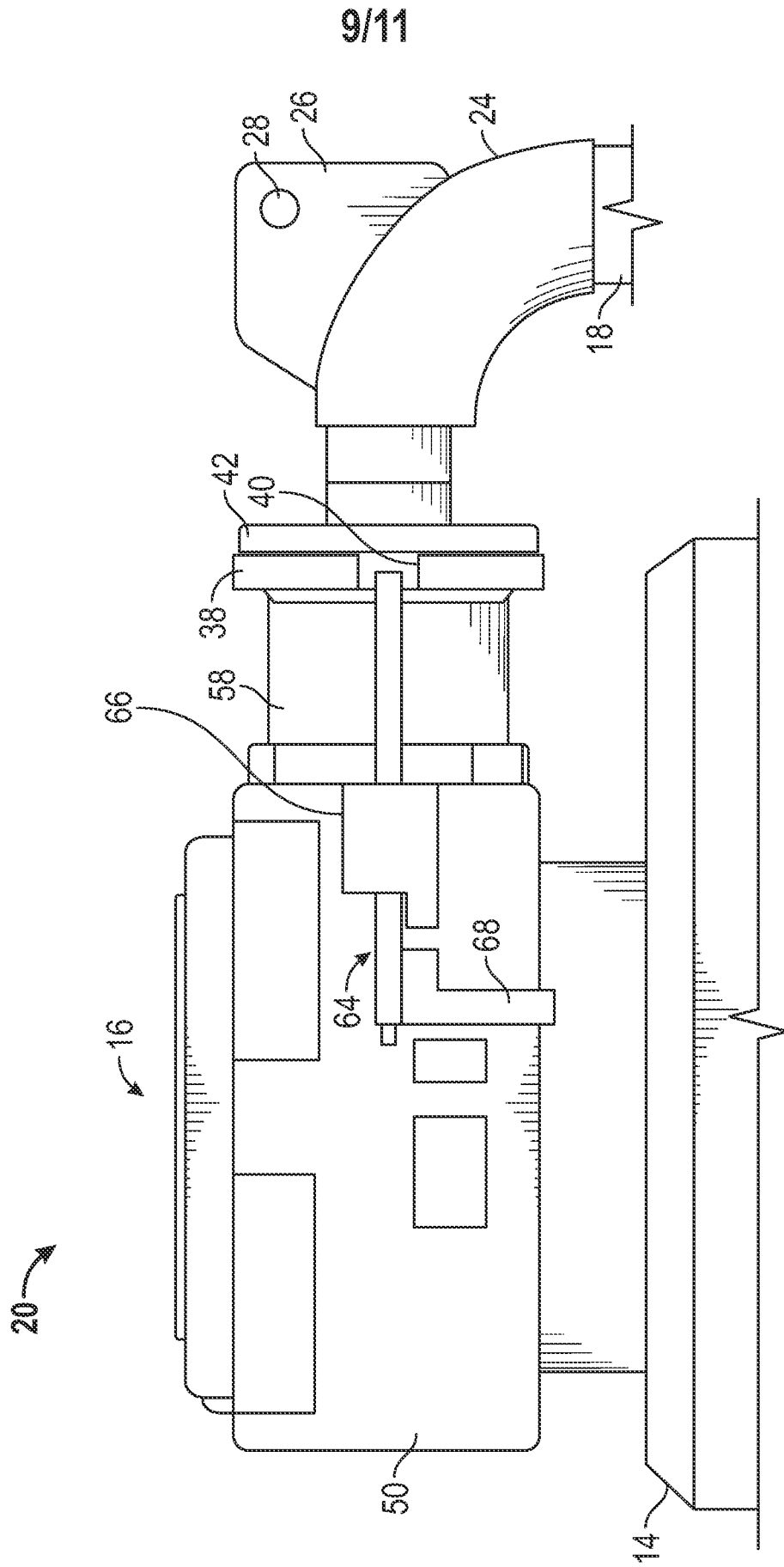


FIG. 10

10/11

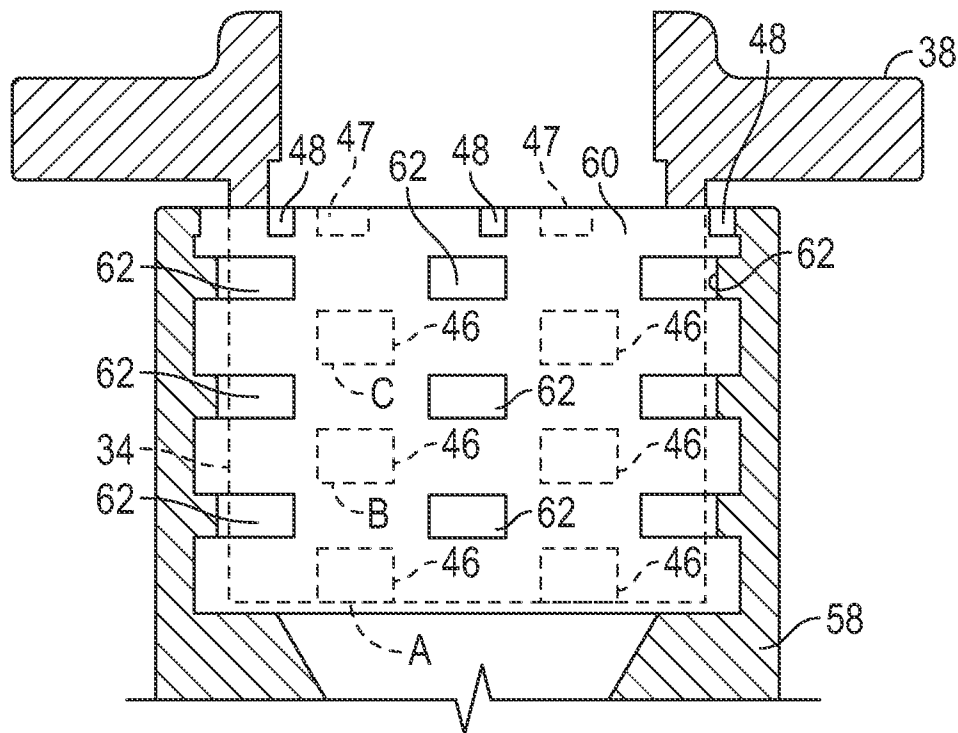


FIG. 11

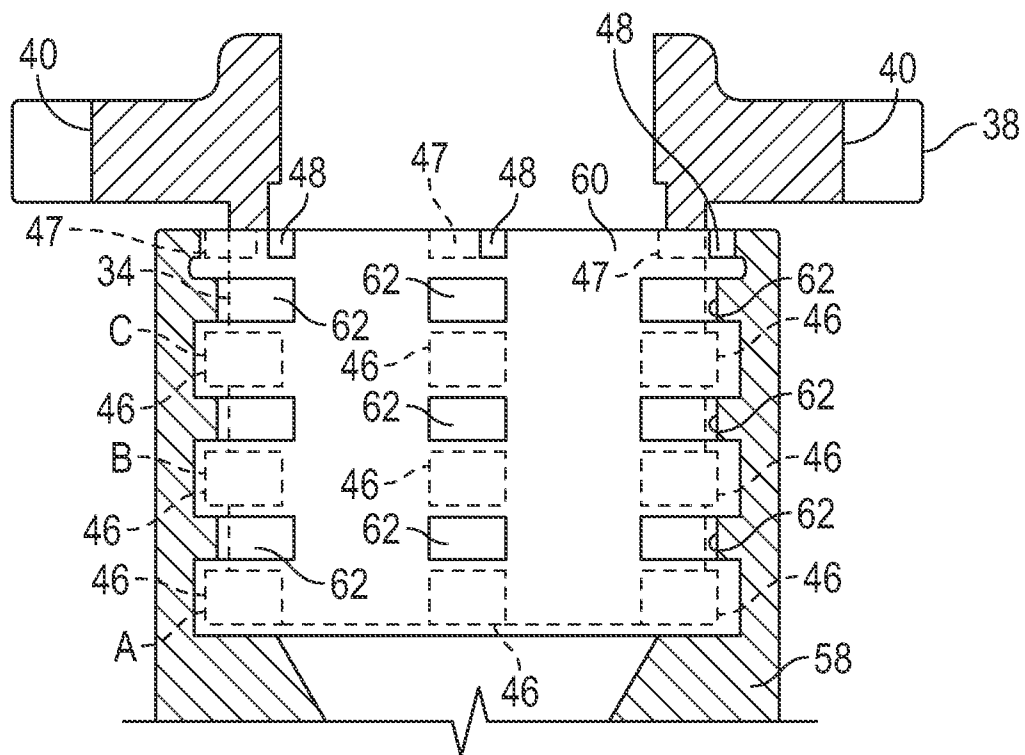


FIG. 12

11/11

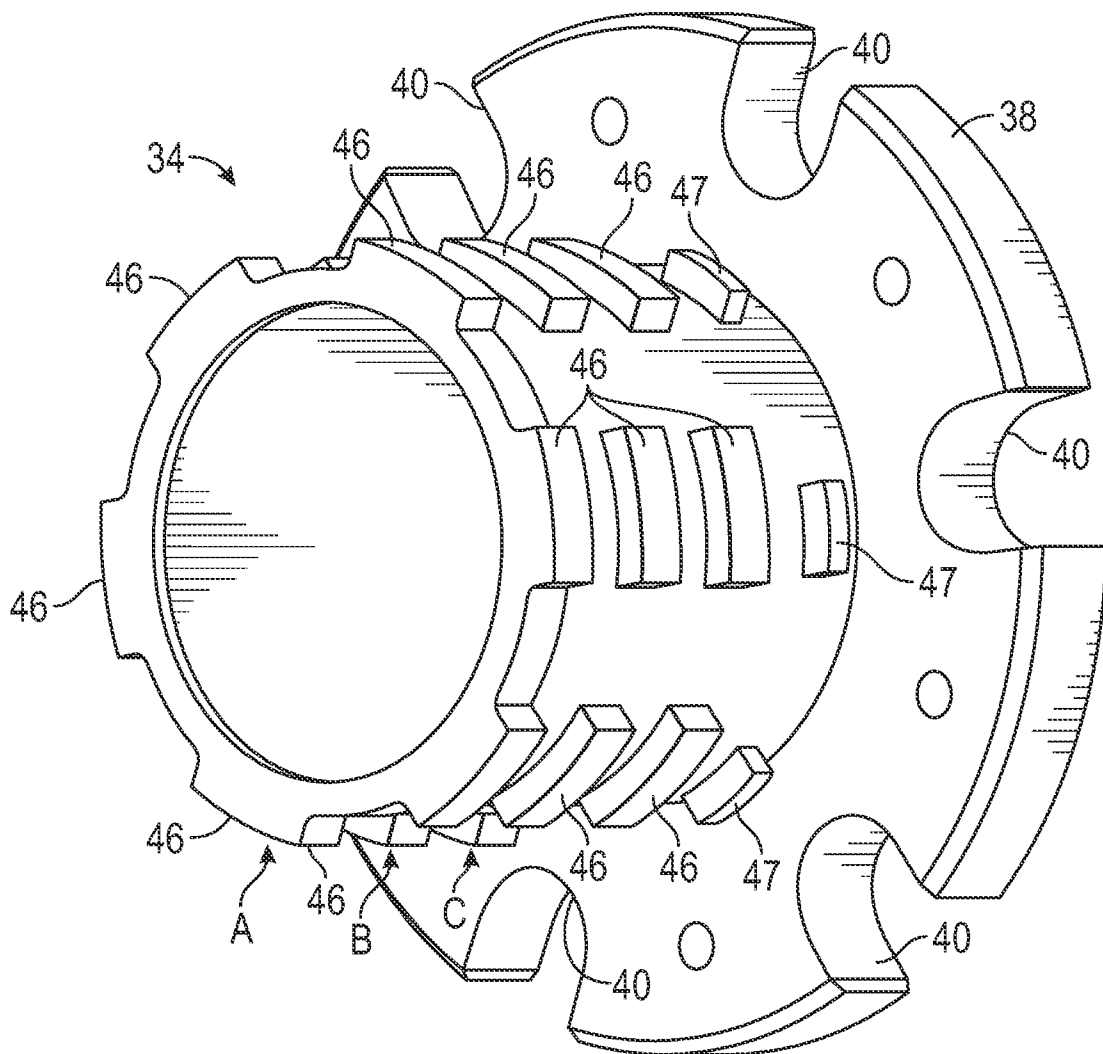


FIG. 13

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2013/037599**A. CLASSIFICATION OF SUBJECT MATTER****E21B 33/13(2006.01)i, E21B 17/02(2006.01)i, F16L 21/02(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 33/13; E21B 33/038; F16L 35/00; E21B 33/064; E21B 33/16; F16L 37/24; E21B 17/02; F16L 21/02

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:coupling, cement operation, swivel, breech lock, and releasably

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	WO 2011-143654 A2 (GULFSTREAM SERVICES, INC. et al.) 17 November 2011 See page 6, lines 20-27 and figure 1A.	1-16
Y	EP 1589188 A2 (CONTROL FLOW INC.) 26 October 2005 See paragraphs [0043]-[0046], [0055], [0060] and figures 5, 7-8, 10-12.	1-16
A	US 3895829 A (MANSON, JR., CHARLES D.) 22 July 1975 See column 2, lines 1-62, and figure 3.	1-16
A	US 2006-0283593 A1 (ROBICHAUX, KIP M. et al.) 21 December 2006 See paragraphs [0043], [0047] and figures 1-2.	1-16
A	US 3948545 A (BONDS, JAMES VAULL) 06 April 1976 See column 3, line 59 - column 4, line 31 and figures 1-2.	1-16



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 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

08 August 2013 (08.08.2013)

Date of mailing of the international search report

12 August 2013 (12.08.2013)

Name and mailing address of the ISA/KR

Korean Intellectual Property Office
189 Cheongsu-ro, Seo-gu, Daejeon Metropolitan City,
302-701, Republic of Korea

Facsimile No. +82-42-472-7140

Authorized officer

LEE Jong Kyung

Telephone No. +82-42-481-3360



INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/US2013/037599

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 2011-143654 A2	17/11/2011	AU 2011-252793 A1 CA 2798771 A1 EP 2569508 A2 MX 2012013265 A US 2011-0232923 A1 WO 2011-143654 A3	29/11/2012 17/11/2011 20/03/2013 24/01/2013 29/09/2011 05/04/2012
EP 1589188 A2	26/10/2005	BR PI0503005 A EP 1491717 A2 EP 1491717 A3 EP 1491717 B1 EP 1589188 A3 NO 20051701 A NO 20051701 D0 SG 116624 A1 US 2004-0256096 A1 US 2004-0256107 A1 US 7040393 B2 US 7163054 B2	06/12/2005 29/12/2004 16/02/2005 03/10/2007 01/03/2006 20/10/2005 06/04/2005 28/11/2005 23/12/2004 23/12/2004 09/05/2006 16/01/2007
US 3895829 A	22/07/1975	None	
US 2006-0283593 A1	21/12/2006	AU 2003-273309 A1 CA 2532793 A1 CA 2532793 C EP 1540131 A2 EP 1540131 B1 EP 1540131 B8 EP 1870558 A2 EP 1870558 A3 US 2005-0034853 A1 US 2006-0289154 A1 US 2008-0087430 A1 US 2008-0179058 A1 US 2009-0223666 A1 US 2012-080201 A1 US 2013-014949 A1 US 7007753 B2 US 7249632 B2 US 7281582 B2 US 7500518 B2 US 7510007 B2 US 7845408 B2 US 8047290 B1 US 8201627 B2 US 8408302 B2 WO 2004-022903 A2 WO 2004-022903 A3 WO 2006-078883 A2	29/03/2004 18/03/2004 10/08/2010 15/06/2005 31/10/2007 12/12/2007 26/12/2007 24/06/2009 17/02/2005 28/12/2006 17/04/2008 31/07/2008 10/09/2009 05/04/2012 17/01/2013 07/03/2006 31/07/2007 16/10/2007 10/03/2009 31/03/2009 07/12/2010 01/11/2011 19/06/2012 02/04/2013 18/03/2004 17/02/2005 27/07/2006

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/US2013/037599

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 3948545 A	06/04/1976	None	
		WO 2006-078883 A3	22/11/2007