

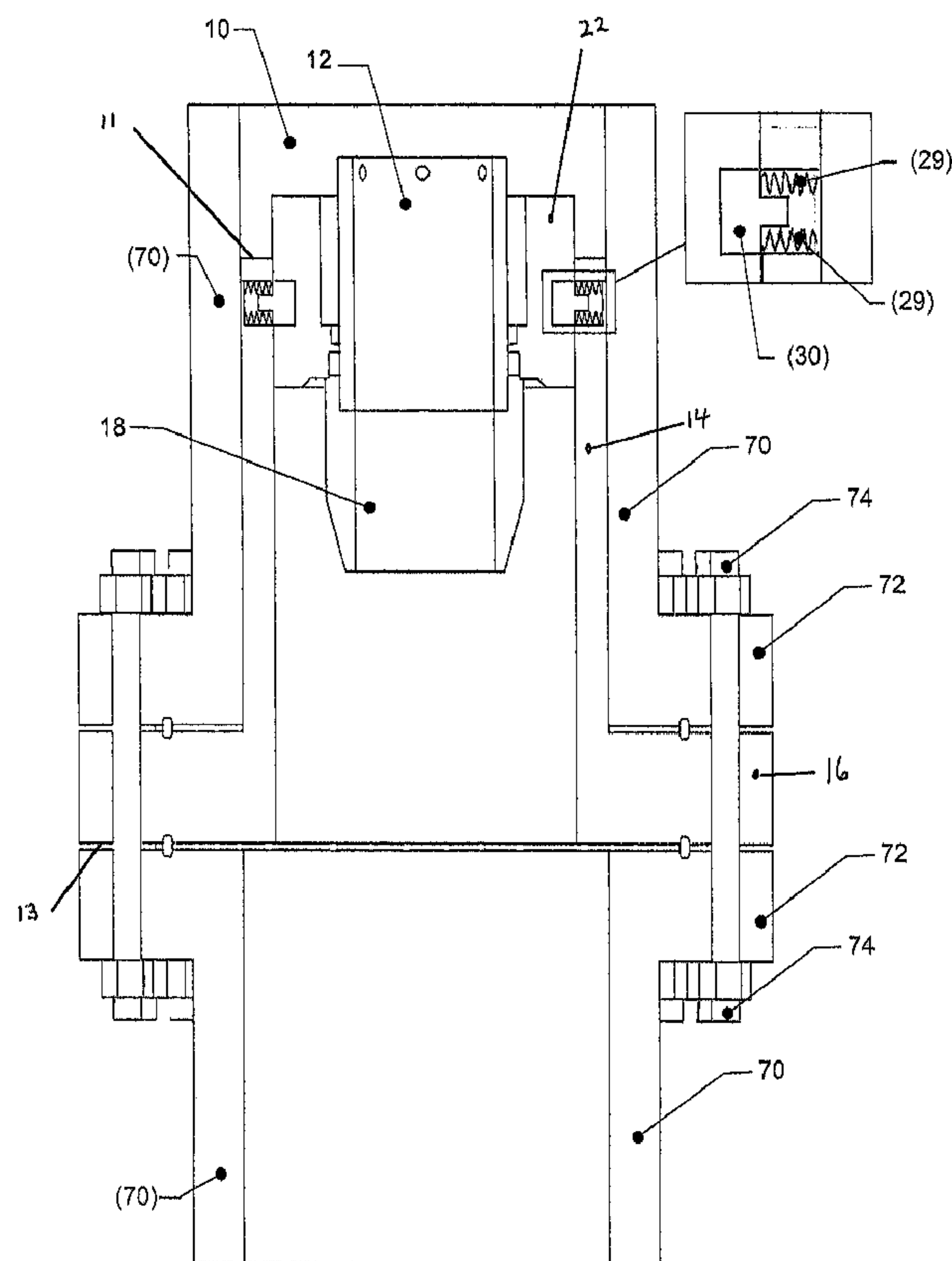


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(54) Titre : DISPOSITIF ROTATIF DE REGULATION D'ECOULEMENT A L'INTERIEUR D'UNE COLONNE MONTANTE
(54) Title: INTERNAL RISER ROTATING FLOW CONTROL DEVICE

FIG. 3



(57) Abrégé/Abstract:

A rotating flow control device, and more particularly a rotating control flow device for use inside a riser assembly during offshore drilling activities. The rotating flow control device has a stationary housing adapted to mount between the interconnected ends of



(57) **Abrégé(suite)/Abstract(continued):**

riser pipe. The bearing assembly of the rotating flow control device is entirely contained within the riser pipe and maybe remotely detached and removed from the stationary housing. The rotating flow control device may be positioned in the riser such that it effectively isolates the riser slip joint from pressurized well bore returns.

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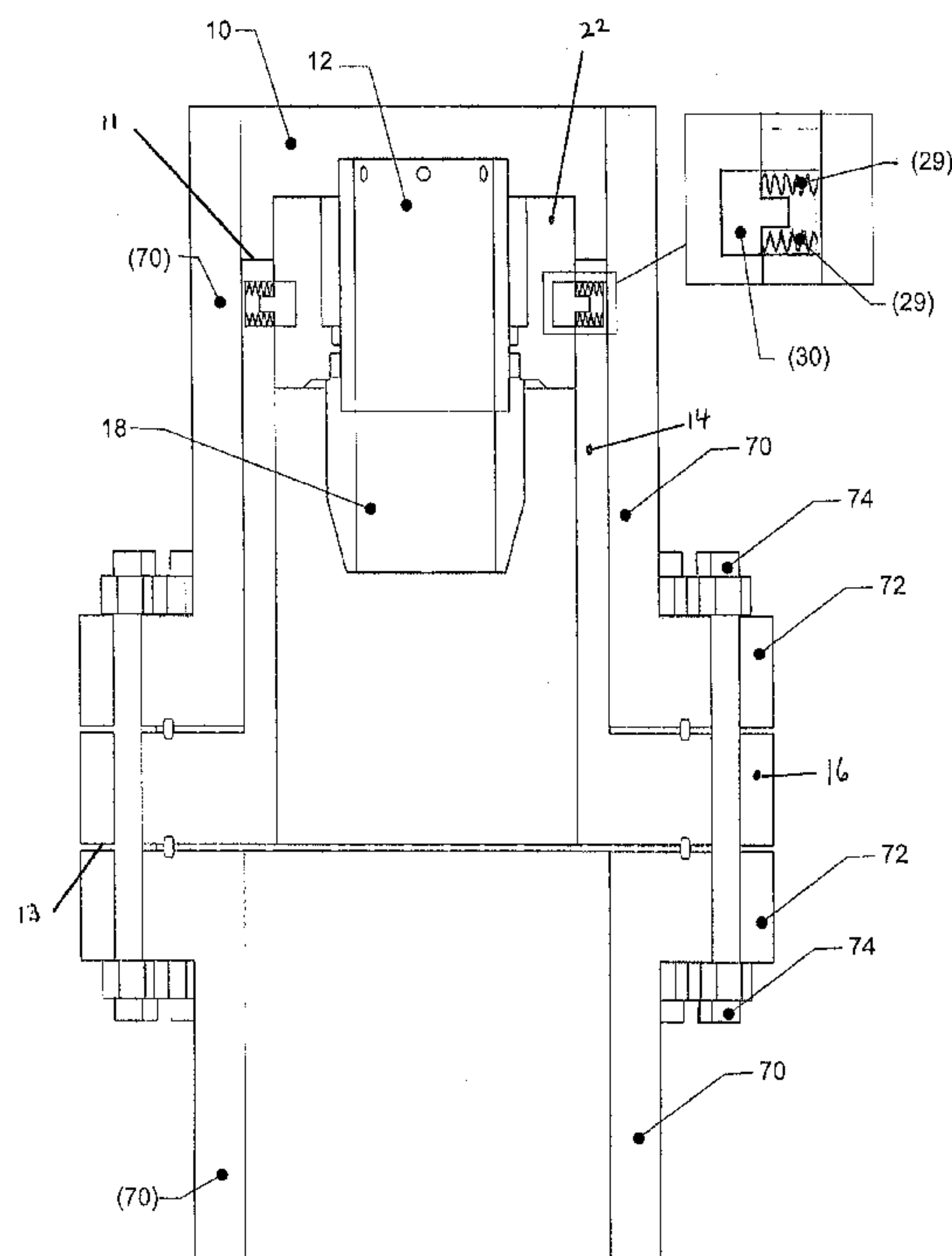
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ing control flow device for use inside a riser assembly during offshore
drilling activities. The rotating flow control device has a stationary housing
adapted to mount between the interconnected ends of riser pipe. The bearing
assembly of the rotating flow control device is entirely contained within the
riser pipe and maybe remotely detached and removed from the stationary
housing. The rotating flow control device may be positioned in the riser such
that it effectively isolates the riser slip joint from pressurized well bore re-
turns.

INTERNAL RISER ROTATING FLOW CONTROL DEVICE

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ASSIGNEE(S): None

DOCKET NO.: 65924.32

Field of the Invention

[0001] The present invention relates to a rotating flow control device, and more particularly to a rotating flow control device for use inside a riser.

Background

[0002] Oil and gas offshore drilling operations require the use of a 'riser', or 'riser string' as it is also known. The riser consists of a string of pipe that extends from a floating drilling platform down to the sea floor. The riser string is comprised of lengths of riser pipe that are attached end to end by means of flanged or custom connections. Drilling mud, cuttings and hydrocarbon products from the borehole in the seafloor are returned to the drilling platform through the riser. The top of the riser is attached to the drilling platform while its lower end is secured to the wellhead on the seafloor. Immediately below the drilling platform, the riser has a slip joint, or tension joint as it is also known, that is configured to telescope to compensate for the heave and swell that the floating drilling platform experiences in the sea. A blow out preventer (hereafter a "**BOP**") is placed between the wellhead and the riser to provide protection against the sudden release of gas which can arise if the drilling operations

encounter pressurized formations. To promote safety and control, a second BOP is also frequently placed at the top of the riser proximate to the drilling platform.

[0003] It is also conventional to use a rotating flow control device (hereafter a "RFCD") at the level of the drilling platform in conjunction the BOP. The RFCD serves multiple purposes including the provision of a pressure seal around drill pipe that is being moved in and out of the riser and the wellbore while allowing rotation of same. Conventional diverters are also placed at the head of the riser above the slip joint to divert wellbore returns to the surface separation and storage equipment.

[0004] While the use of a BOP and a RFCD at the head of a riser provides a pressure seal and a barrier between the external environment and the wellbore returns, such configuration can be problematic. If the lower BOP stack fails, or if there is a sudden release of gas or pressurized fluid into the riser for any other reason (for example; solution gas assuming gaseous form as it ascends the riser), control of the pressurized gas or fluid in the riser occurs at the level of the drilling platform using the BOP stack, the RFCD and the diverter. This can result in exposure of the drilling platform to dangerous risk if the pressure and volume of the wellbore return within the riser exceeds the pressure rating of the riser, or if the capacity of the surface equipment to deal with this type of event is not adequate.

[0005] The RFCD of the present invention seeks to mitigate these problems by being positioned in the riser string in a position below the drilling platform and the weakest pressure rated assembly in the riser string, namely the slip joint, thus giving the riser string a greater typical pressure integrity. The RFCD of the present invention creates a pressure seal that isolates the

pressurized wellbore returns in the riser below the drilling platform such that it can be contained and diverted if required at a subsurface level thereby substantially eliminating the exposure of the drilling platform to danger. The RFCD of the present invention provides an additional safety system to compliment the surface level BOP and RCFD.

[0006] A subsurface RFCD is described in US 2006/0102387 to Bourgoyne *et al.* However, such device is integrated in the riser string such that its housing forms part of the riser string and is therefore load bearing. Mechanical stress and pressure loads on the riser string, which has an inclination to move with the swell of the surrounding water, can impede the mechanical performance of the RFCD and can compromise its pressure integrity.

[0007] Accordingly, there is a need for a RFCD that can be used to create an additional pressure seal between the wellbore and the external environment which can be mounted in the riser assembly in a position that is below the slip joint and the drilling platform. The RFCD should be configured such that it is not a load bearing component of the riser string, thereby mitigating the risk of mechanical failure due to load stress on the riser string. It would be preferable if the bearing assembly of the apparatus could be installed and un-installed remotely for maintenance, and if the device were robust and relatively simple.

Summary of the Invention

[0008] In one embodiment of the present invention, the invention comprises a rotating flow control device apparatus for use inside a riser, the riser comprising a string of riser pipes, each such riser pipe having two ends whereby the ends of adjacent riser pipes are interconnected to form the string, the apparatus comprising;

- (a) a tubular stationary housing mounted inside the riser, the stationary housing having a first end and a second end, the second end having a connector, the connector being adapted to form part of the interconnection between the ends of two interconnected adjacent riser pipes whereby the second end of the stationary housing is rigidly attached to the riser and the first end of the stationary housing is contained within but not attached to the riser;
- (b) a removable bearing assembly releasably mounted on the stationary housing, the bearing assembly comprising an outer housing, and an axially rotatable inner tubular shaft; and
- (c) a stripper element attached to the inner tubular shaft.

[0009] In one embodiment the ends of the riser pipe are flanged and the connector at the second end of the stationary housing is flanged. In a further embodiment, the flanged connector of the stationary housing is sandwiched between the flanged ends of the interconnected adjacent riser pipes. In a further embodiment, the flanged connector and the flanged ends of the riser pipe have aligned bolt holes and bolts are employed to secure the interconnection.

[0010] In one embodiment, the bearing assembly is releasably mounted on the stationary housing by means of a moveable latch projecting from the stationary housing that engages a complementary pocket in the outer housing of the bearing assembly. In another embodiment, the moveable latch is spring loaded. In further embodiments, the moveable latch may be actuated remotely using hydraulic pressure or pneumatic pressure. In one embodiment, there are a plurality of spring loaded latches and a plurality of complementary pockets. In another

embodiment, the riser further comprises a slip joint and the apparatus is mounted in the riser beneath the slip joint. In one embodiment, the stripper element is elastomeric.

[0011] In another aspect of the present invention, the invention comprises a system for controlling pressurized wellbore returns in a riser extending from a surface drilling platform to a subsea wellhead, the system comprising;

- (a) the rotating flow control device apparatus described in the preceding paragraphs;
- (b) a flow spool having at least one port, the flow spool being positioned in the riser between the apparatus and the wellhead; and
- (c) the at least one port of the flow spool being connected to a pipe extending to the surface and whereby the at least one port may be selectively opened and closed remotely from the drilling platform.

[0012] In another aspect of the invention, the invention comprises a rotating flow control device apparatus for use inside a conventional riser pipe, the riser pipe having a first end and a second end, the apparatus comprising;

- (a) a stationary housing having a first end and a second end;
- (b) a bearing assembly comprising an outer housing, and an axially rotatable inner tubular shaft, the bearing assembly being releasably mounted on the stationary housing; and
- (c) an elastomeric stripper element attached to the inner tubular shaft;

- (d) whereby the second end of the stationary housing is adapted to rigidly attach to either the first or second end of the riser pipe and whereby the bearing assembly is entirely contained within the riser pipe.

[0013] In one embodiment, the ends of the riser pipe are flanged and the second end of the stationary housing forms a complementary flanged connector. In another embodiment, the bearing assembly is releasably mounted on the stationary housing by means of a moveable latch projecting from the stationary housing that engages a complementary pocket in the outer housing of the bearing assembly.

[0014] Brief Description of the Drawings

[0015] In the drawings, like elements are assigned like reference numerals. The drawings are not necessarily to scale, with the emphasis instead placed upon the principles of the present invention. Additionally, each of the embodiments depicted are but one of a number of possible arrangements utilizing the fundamental concepts of the present invention. The drawings are briefly described as follows:

[0016] Figure 1 is a diagrammatic depiction of one embodiment of an offshore drilling operation including a riser having a rotating flow control device of the present invention.

[0017] Figure 2 is a diagrammatic view through a vertical cross section of one embodiment of the apparatus of the present invention.

[0018] Figure 3 is a diagrammatic view through a vertical cross section of a riser with one embodiment of the apparatus of the present invention mounted therein.

[0019] Figure 4 is a diagrammatic depiction of the flanged interconnection of two adjacent sections of riser pipe with the flanged connection of one embodiment of the apparatus of the present invention sandwiched therebetween.

[0020] Figure 5 is a diagrammatic depiction of a portion of a riser string with a vertical cross sectional view of one embodiment of the apparatus of the present invention.

Detailed Description

[0021] The invention relates to a rotating flow control device ("RFCD") for use in the riser of an offshore drilling operation. When describing the present invention, all terms not defined herein have their common art-recognized meanings. To the extent that the following description is of a specific embodiment or a particular use of the invention, it is intended to be illustrative only, and not limiting of the claimed invention. The following description is intended to cover all alternatives, modifications and equivalents that are included in the spirit and scope of the invention, as defined in the appended claims.

[0022] Offshore oil and gas drilling operations conducted on the sea floor require the use of riser. As shown in Figure 1, the riser (50) extends from the drilling platform (51) down to the sea floor (53). The drilling platform (51) may comprise a floating rig or a drill ship, or any like surface platform employed by the offshore drilling industry.

[0023] Once a wellbore (64) has been established in the sea bed (53) and casing (62) has been cemented into place in the wellbore (64), a BOP stack (60) is landed on and secured to the well head (not shown in the figures). The BOP (60) is connected to the riser (50) which

extends to the drilling platform (51). The blow out preventer (60) is tested to ensure operational functionality following which, drilling operations commence through the riser (50) in an incremental manner. Drill pipe (not shown) is lowered down through the riser (50) and drilling mud is injected down through the drill pipe. Drilling mud, cuttings and hydrocarbon returns from the borehole travel up to the drilling platform (51) through the riser (50). Immediately below the drilling platform (51), the riser (50) has a slip joint (54) that is configured to telescope in an open and closed fashion to compensate for the heave and swell that the floating drilling platform (51) experiences in the sea. The slip joint (54) prevents the riser (50) from being pulled or pushed off the well head as the drilling platform (51) raises and lowers with the movement of the sea.

[0024] The riser (50) is comprised of a string of interconnected sections of riser pipe (70). Commonly the riser pipe sections (70) are flanged at each end. The flanged ends of the riser pipe sections (72) attach in a complementary manner and are secured by bolts (74) as shown in Figures 4 and 5. However, the description of flanged riser pipe ends is not intended to be limiting of the invention claimed herein and it will be understood by one skilled in the art that there are other suitable means for connecting the ends of riser pipes that are employed in the industry. The apparatus of the present invention may also be used with riser pipe having such other connection means.

[0025] As shown in Figure 1, a second BOP (65) may be employed proximate to the drilling platform (51). As also shown in Figures 1 and 5, it is conventional to use a RFCD (67) at the head on the riser on the drilling platform (51). The surface RFCD (67) serves multiple

purposes including the provision of a pressure seal around tubular are being tripped in and out of the riser (50), and ultimately the wellbore (64) itself, while allowing rotation of the tubulars. A conventional diverter (56) is also placed at the head of the riser (50) beneath the surface RFCD (67) to divert wellbore returns from the riser (50) to the surface separation and storage equipment (not shown).

[0026] The use of a BOP (65) and a RFCD (67) at the head of a riser (50) provides a pressure seal and a barrier between the external environment and the wellbore returns, however, such configuration can be problematic. If the lower BOP stack (60) fails, or if there is a sudden release of gas or pressurized fluid into the riser for any other reason (for example; solution gas assuming gaseous form as it ascends), control of the pressurized gas or fluid in the riser (50) occurs at the level of the drilling platform (51) using the BOP stack (65), the RFCD (67) and the diverter (56). This can result in exposure of the drilling platform (51) to dangerous risk if the pressure and volume of the wellbore return within the riser (50) exceeds the pressure rating of the riser (50), or if the capacity and pressure rating of the surface equipment to deal with this type of event is not adequate. For example, should the pressure in the riser (50) exceed the weakest pressure rated link in the riser string, which is typically a 500 psi maximum pressure rated slip joint (54) located immediately below the diverter (56) and drilling platform (51), then to preclude mechanical failure of the riser (50) the diverter (56) is usually configured to automatically open a control port to vent the wellbore returns to relieve pressure. This results in the sudden release of pressurized hydrocarbon product at surface level that can potentially ignite resulting in an explosion at surface. Further, if venting using the diverter (56) does not successfully reduce the

pressure in the riser (50), mechanical failure in the riser string or the well head may occur resulting in uncontrolled introduction of wellbore returns into the sea and external environment.

[0027] The present invention seeks to mitigate these problems by positioning a RFCD apparatus (10) in the riser (50) in a position below both the drill platform (51) and the weakest pressure rated assembly in the riser string, namely the slip joint (54), thus giving the riser (50) a much greater typical pressure integrity. In one embodiment, a riser (50) employing the apparatus of the present invention (10) may have a pressure integrity of up to 1500 psi. The RFCD of the present invention (10) creates a pressure seal that isolates the pressurized wellbore returns in the riser (50) below the drilling platform (51) such that it can be contained and diverted if required at a subsurface level thereby substantially eliminating the exposure of the drilling platform to danger. The RFCD of the present invention (10) provides an effective additional safety system to compliment the surface level diverter (56), BOP (65) and the surface RFCD (67).

[0028] A rotating flow control device typically consists of rubber strippers or sealing elements and an associated hollow quill that rotates with the drill string within a robust housing. Rotation of the strippers and the hollow quill is facilitated by a bearing assembly having an inner race that rotates with the drill string and an outer race that remains stationary with the housing. The bearing assembly is isolated from the corrosive wellbore fluids and gases by seals.

[0029] Figure 2 depicts one embodiment of a RFCD (10) of the present invention. As can be seen in Figure 2, the rotating flow control device (10) comprises a stationary housing (14) having a first end (11) and a second end (13). The second end (13) has a connector (16)

adapted to rigidly attach to the riser (50) by forming part of the interconnection between sections of adjacent riser pipes (70). In the embodiment depicted, the connector (16) at the second end of the stationary housing (13) is formed into a flange connection, to operatively connect with the flanged ends (72) of sections of riser pipe (70). As previously described, the connector (16) at the second end of the stationary housing (13) does not have to be restricted to only a flanged connector with bolt holes and may be configured to be complementary to any type of connection system that is being employed to connect the ends of sections of adjacent riser pipe provided that a rigid attachment to the riser (50) at the second end of the stationary housing (13) can be achieved.

[0030] The stationary housing (14) has a bore (28) for receiving fluid and gas from the riser (50) and wellbore (64). The RFCD (10) has a sealed bearing assembly (15) having an axially rotatable inner tubular shaft (12) disposed therein. The inner tubular shaft (12) has an elastomeric stripper element (18) supported at a downhole end of the inner tubular shaft (12). The stripper element (18) is well known in the industry and may be constructed from any suitable rubber, elastomer or polymer substance.

[0031] The bearing assembly (15) has a robust outer housing (22). The bearing assembly outer housing (22) and the inner tubular shaft (12) form an annular space (24) disposed in which is a bearing element (not shown). The bearing elements may comprise any suitable type used for like purposes by those skilled in the art, and may be arranged in any manner in the annular space (24) that provides appropriate axial and radial support to the inner tubular shaft (12). Any suitable lubricating fluid may be utilized in the annular space to cool and

lubricate the bearing element. The bearing element is isolated from the wellbore fluid by a lower seal (20). As shown in Figure 2, the elastomeric stripper element (18), the lower seal (20) and the outer housing (22) of the bearing assembly (15) form a pressure seal on a tubular.

[0032] The stationary housing (14) and the outer housing of the bearing assembly (15) and the inner tubular shaft (12) may be constructed from any suitable metallic material including, without limit, 41/30 alloy steel.

[0033] In operation, for diverting and recovering wellbore returns from the riser (50) below the RFCD (10), a flow spool (58) having one or more ports or outlets is positioned in the riser string beneath the RFCD (10). The flow spool (58) is connected to pipes or hoses (59) which travel to the surface for the selective discharge of well fluids and gases. The outlets in the flow spool (58) may be opened and closed remotely using surface controls to facilitate the selective venting and diversion of the well bore returns.

[0034] As shown in Figure 2, the stationary housing (14) defines a pocket (33) containing a spring (29) loaded metal finger or latch (30). The springs (29) are biased to urge the latch (30) in a direction towards the interior of the housing (14). The embodiment shown depicts one continual ring shaped latch, however, in an alternative embodiment there may be a plurality of discrete individual latches. The outer housing (22) of the bearing assembly (15) defines a complementary recess or pocket (31) that receives the latch (30) (or a plurality of pockets to receive a plurality of latches as the case may be). The latch (30) is hydraulically or pneumatically actuated remotely from the drilling platform. Accordingly, an operator may remove and reinstall the bearing assembly (15) and associated inner tube (12) and stripper

element (18) by using pneumatic or hydraulic pressure to cycle the spring loaded latches (30). When the latch (30) is engaged in the pocket (31) of the outer housing (22) of the bearing assembly (15), the bearing assembly (15) and associated inner tube (12) will be securely held in place in the stationary housing (14) creating a pressure seal in the riser (51). Activation of the hydraulic or pneumatic pressure will cause the latches (30) to retract by compressing the springs (29) and the bearing assembly (15), inner tube (12) and elastomeric stripper element (18) may be removed through the riser (51). This arrangement facilitates easy removal for maintenance and parts replacement.

[0035] It can be understood that the bearing assembly (15) and associated inner tube (12) may be lowered from the drilling platform down the riser string (50) to the stationary housing (14) when required on a tubular string. Once in place, pressure on the latches (30) is released allowing the springs (29) to urge the latches (30) into the pockets in the outer housing (22) of the bearing assembly (15) to secure the bearing assembly (15) in place. The bearing assembly (15) and associated inner tube (12) may be removed following the reverse operation. If the stripper element (18) is not too compromised, removal may be effected using a tubular, however, if the stripper element (18) is unable to form an adequate seal on a tubular, then a recovery tool may be used for removal.

[0036] Although spring loaded latches and complementary pockets are detailed in the embodiment described herein, one skilled in the art will understand that any suitable locking system that may be remotely actuated can be employed to releasably mount the bearing assembly (15) on the stationary housing (14).

[0037] If the connector (16) is configured to comprise a flange connection as shown in the Figures, it can be an API flange or can be custom sized to match riser pipe flange connections. As shown in Figures 4 and 5, in one embodiment, the flanged connector (16) of the stationary housing (14) of the rotating flow control device (10) is sandwiched between the flanges (72) of two adjacent riser pipe sections (70). Bolts (74) extend through bolt holes (75) and hold the three flanged elements together. In this manner, the rotary flow control device (10) of the present invention may be mounted anywhere in the riser string where there is such a flanged connection. Figure 1 depicts the apparatus of the present invention (10) in a riser string.

[0038] It can be understood from the Figures that once the connector (16) is rigidly attached to the riser (50) by forming part of the interconnection between adjacent sections of riser pipe (70), the stationary housing (14) is self supporting and does not form part of the load path of the riser (50) itself. Further, the outer housing (22) of the bearing assembly (15) also does not form part of the load bearing riser string. Accordingly load stress placed on the riser (50) will not impede or interfere with the performance of the RFCD (10) of the present invention.

[0039] Once in place, the apparatus (10) provides a seal on drill pipe or casing that is being run into or out of the wellbore (64) and provides an additional pressure barrier between the external environment and the wellbore (64) at a subsea level below the drilling platform (51). It also isolates the relatively weak slip joint (54) from pressurized well bore returns.

[0040] In operation, in the event of failure of the lower BOP stack (60) or the introduction of pressurized gas or fluid into the riser (50), the RFCD (10) of the present invention will form a pressure seal thus precluding exposure of the slip joint (54) and the drilling platform (51)

components to the pressurized fluid or gas. If venting is required to reduce the pressure in the riser (50) beneath the RFCD (10), ports in the flow spool (58) may be opened and the associated hose or pipe (59) will conduct the vented substances to a location that is a safe distance from the drilling platform. In this manner the RFCD (10) and the flow spool (58) comprise a system for controlling pressurized wellbore returns in a riser.

[0041] The RFCD (10) of the present invention may be employed for well control operations, to promote safety and to mitigate environmental concerns and to manage high pressure drilling activities.

[0042] Advantages of the internal positioning of the apparatus (10) within the riser (50) include the ability to remotely install and remove the bearing assembly (15), outer housing (22), the inner tubular shaft (12) and the stripper element (18), and the protection of the apparatus (10) from the external sea water environment. Furthermore, the use of a stationary housing (14) that is adapted to mount between the ends of adjacent sections of riser pipe enables the apparatus (10) to operate within the riser (50) without forming an active part of the load path of the riser (50). It can also be understood, the apparatus of the present invention may be mounted within any conventional riser pipe and that it would relatively straightforward to retrofit a riser to incorporate the apparatus of the present invention. Furthermore, the apparatus of the present invention is relatively simple and economical to use.

[0043] As will be apparent to those skilled in the art, various modifications, adaptations and variations of the foregoing specific disclosure can be made without departing from the scope of the invention claimed herein.

WHAT IS CLAIMED IS:

1. A rotating flow control device apparatus for use inside a riser, the riser comprising a string of riser pipes, each such riser pipe having two ends whereby the ends of adjacent riser pipes are interconnected to form the string, the apparatus comprising:
 - (a) a tubular stationary housing mounted inside the riser, the stationary housing having a first end and a second end, the second end having a connector, the connector being adapted to form part of the interconnection between the ends of two interconnected adjacent riser pipes whereby the second end of the stationary housing is rigidly attached to the riser and the first end of the stationary housing is contained within, but not attached to, the riser;
 - (b) a removable bearing assembly releasably mounted on the stationary housing, the bearing assembly comprising an outer housing, and an axially rotatable inner tubular shaft; and
 - (c) a stripper element attached to the inner tubular shaft.
2. The apparatus of claim 1 wherein the ends of the riser pipe are flanged and the connector at the second end of the stationary housing is flanged.
3. The apparatus of claim 2 wherein the flanged connector of the stationary housing is sandwiched between the flanged ends of the interconnected adjacent riser pipes.
4. The apparatus of claim 3 wherein the flanged connector and the flanged ends of the riser pipe have aligned bolt holes and bolts are employed to secure the interconnection.
5. The apparatus of claim 1 wherein the bearing assembly is releasably mounted on the stationary housing by means of a moveable latch projecting from the stationary housing that engages a complementary pocket in the outer housing of the bearing assembly.

6. The apparatus of claim 5 wherein the moveable latch is spring loaded.
7. The apparatus of claim 5 wherein the moveable latch may be actuated remotely using hydraulic pressure.
8. The apparatus of claim 5 wherein the moveable latch may be actuated remotely using pneumatic pressure.
9. The apparatus of claim 5 comprising a plurality of spring loaded latches and a plurality of complementary pockets.
10. The apparatus of claim 1 wherein the riser further comprises a slip joint and the apparatus is mounted in the riser beneath the slip joint.
11. The apparatus of claim 1 wherein the stripper element is elastomeric.
12. A system for controlling pressurized wellbore returns in a riser extending from a surface drilling platform to a subsea wellhead, the system comprising;
 - (a) the apparatus of claim 1;
 - (b) a flow spool having at least one port, the flow spool being positioned in the riser between the apparatus and the wellhead; and
 - (c) the at least one port of the flow spool being connected to a pipe extending to the surface and whereby the at least one port may be selectively opened and closed remotely from the drilling platform.

13. A rotating flow control device apparatus for use inside a conventional riser pipe, the riser pipe having a first end and a second end, the apparatus comprising;
- (a) a stationary housing having a first end and a second end;
 - (b) a bearing assembly comprising an outer housing, and an axially rotatable inner tubular shaft, the bearing assembly being releasably mounted on the stationary housing;
 - (c) an elastomeric stripper element attached to the inner tubular shaft;
- whereby the second end of the stationary housing is adapted to rigidly attach to either the first or second end of the riser pipe and whereby the bearing assembly is entirely contained within the riser pipe.
14. The apparatus of claim 13 wherein the ends of the riser pipe are flanged and the second end of the stationary housing forms a complementary flanged connector.
15. The apparatus of claim 13 wherein the bearing assembly is releasably mounted on the stationary housing by means of a moveable latch projecting from the stationary housing that engages a complementary pocket in the outer housing of the bearing assembly.

1/5

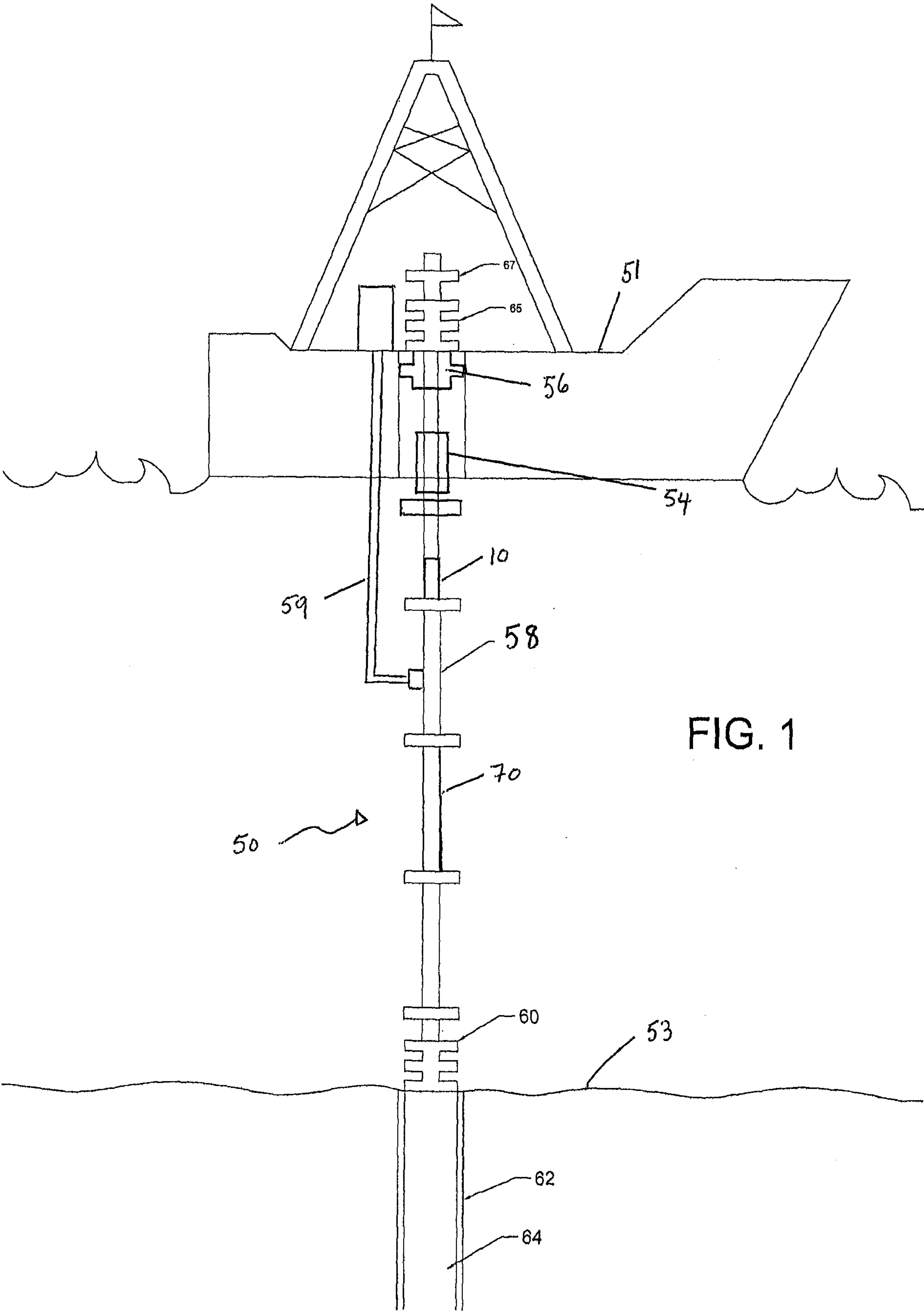
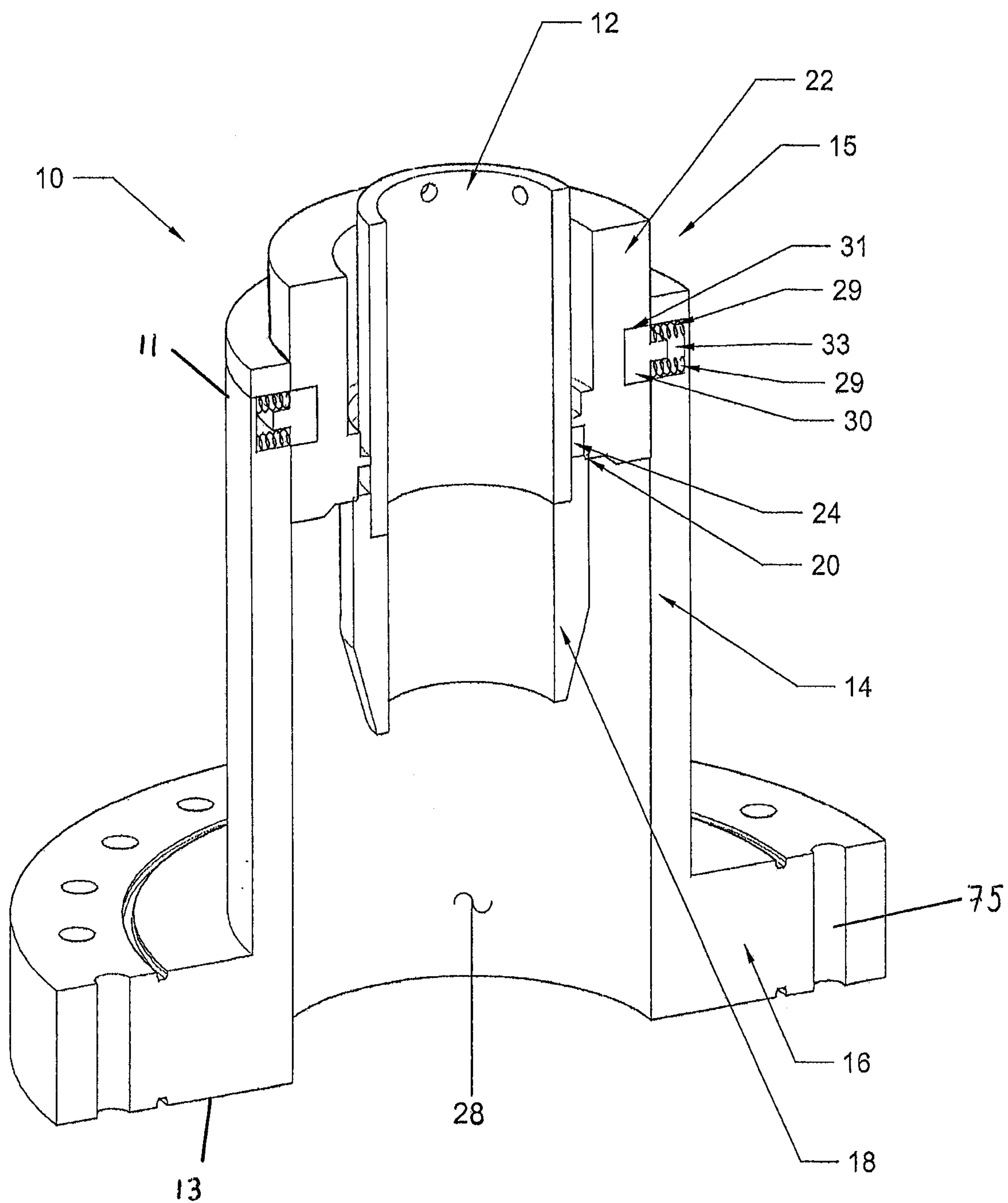
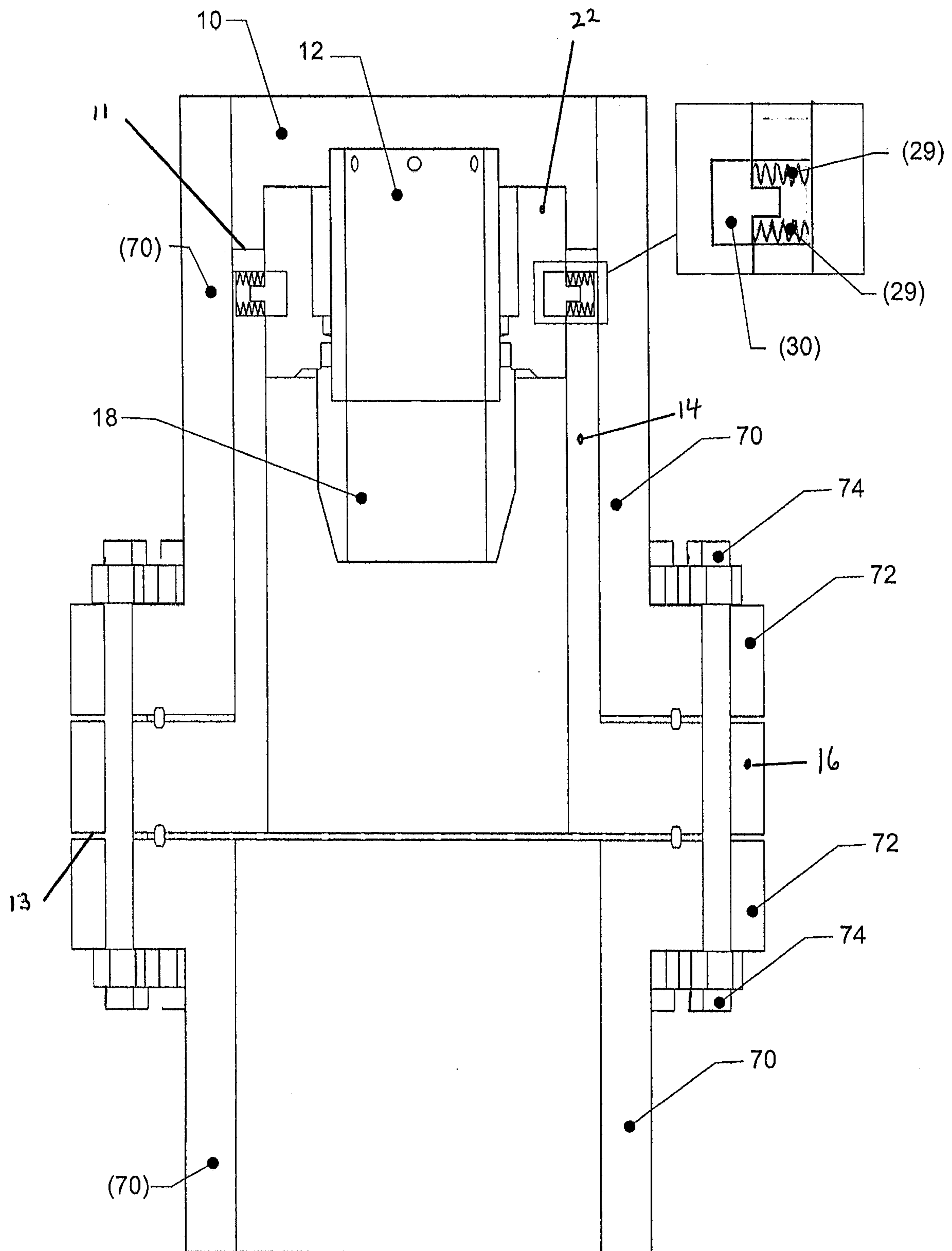


FIG. 2



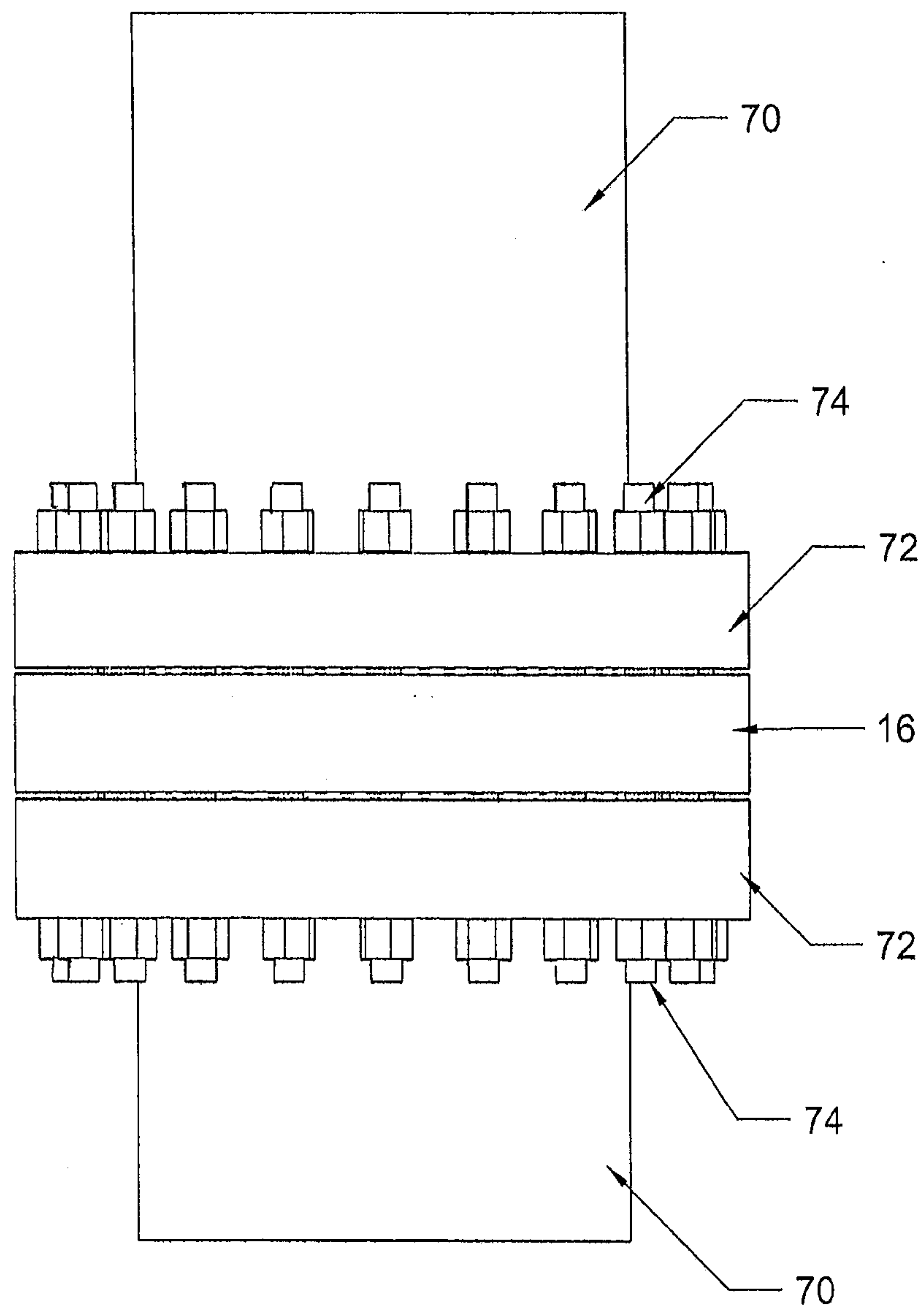
3/5

FIG. 3



4/5

FIG. 4



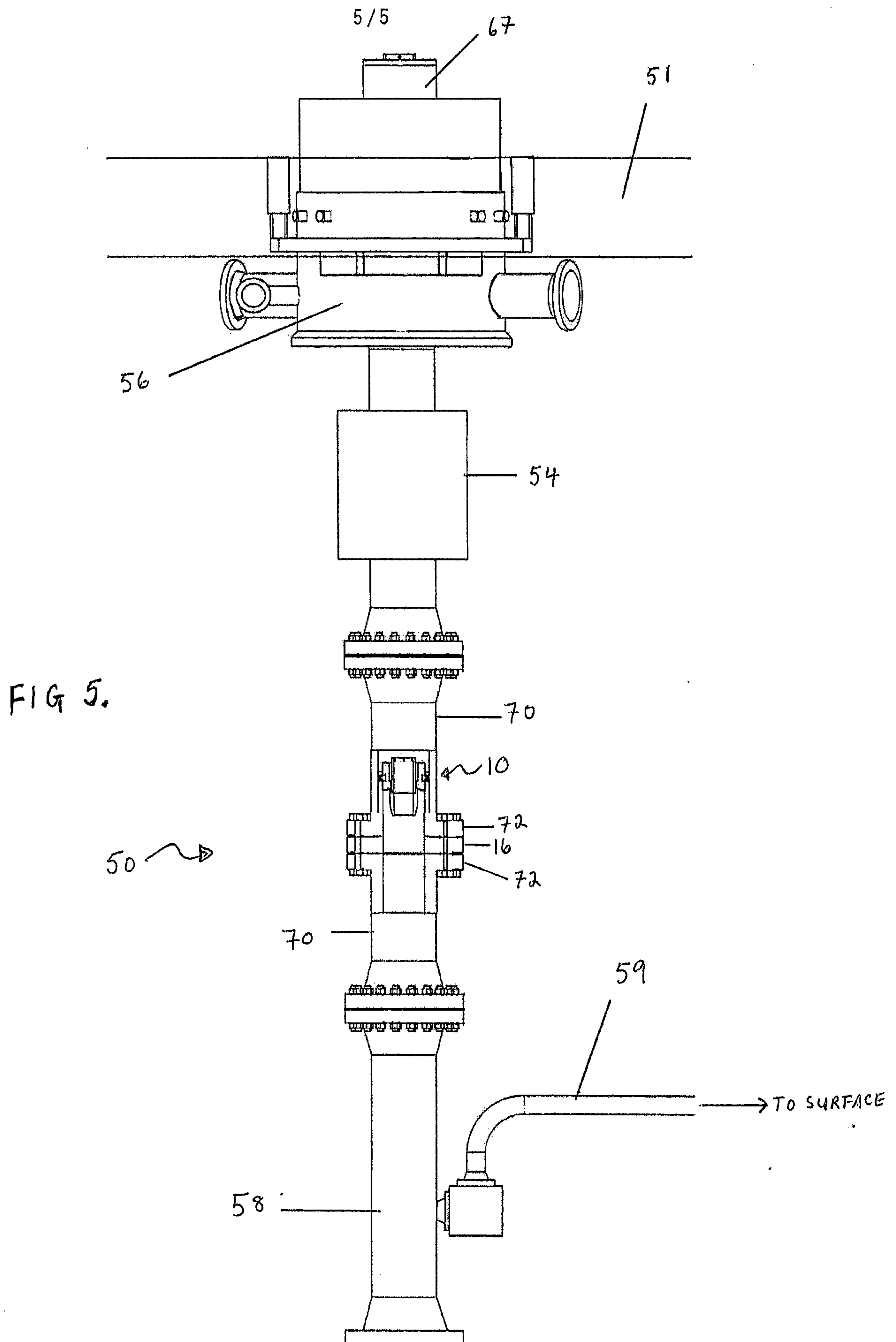


FIG. 3

