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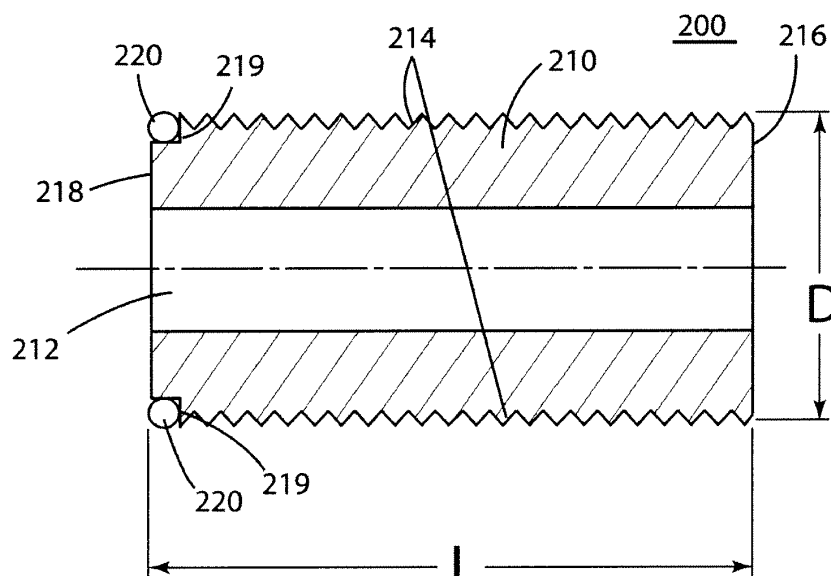
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(54) **Devices and methods for locally replacing seal surface**

(57) Devices and methods useable for repairing seal surfaces in an oil and gas installation used at offshore locations are provided. A removable device useable for locally repair a seal surface of a receiver plate, includes a rigid portion and a seal. The rigid portion is made of a material substantially similar to a material of the receiver plate, and is configured to be removably inserted in a

fluid port of the receiver plate, having a seal surface flushed with the seal surface of the receiver plate when the device is inserted in the fluid port, and a channel configured to allow a fluid communication. The seal is made of a rubber-like material and is placed outside the rigid portion, the seal being configured to prevent a fluid leak.

Figure 4



Description

BACKGROUND

TECHNICAL FIELD

[0001] Embodiments of the subject matter disclosed herein generally relate to devices and methods useable for repairing seal surfaces of an oil and gas installation used at offshore locations, more particularly, to a removable device with a seal surface, a receiver plate having a seal surface and configured to accommodate one or more removable devices, and related methods of locally replacing seal surface.

DISCUSSION OF THE BACKGROUND

[0002] During the past years, with the increase in price of fossil fuels, the interest in developing new production fields has dramatically increased. However, the availability of land-based production fields is limited. Thus, the industry has now extended drilling to offshore locations, which appear to hold a vast amount of fossil fuel.

[0003] An installation for drilling at an offshore location includes a subsea blowout preventer ("BOP") stack useable to seal a wellbore during drilling operations, both for safety and environmental reasons. As shown in FIG. 1, a subsea blowout preventer ("BOP") stack includes a lower blowout preventer stack 10 attached to a wellhead on the sea floor 20, and a Lower Marine Riser Package ("LMRP") 30 at a distal end of a marine riser 40, extending from a drill ship 50 or any other type of surface drilling platform or vessel. When desired, blowout preventers of the LMRP 30 and of the lower BOP stack 10 may be closed. The LMRP 30 may be detached from the lower BOP stack 10 and retrieved to the surface, leaving the lower BOP stack 10 atop the wellhead, on the sea floor 20. Thus, for example, the LMRP 30 may be retrieved when inclement weather is expected or when work on a particular wellhead is to be temporarily stopped. The LMRP 30 may include a stinger 26 at its distal end configured to engage a receptacle 29 located on a proximal end of lower BOP stack 10.

[0004] Various electrical, mechanical, and hydraulic control signals need to be transmitted from the surface vessel 50 to devices (e.g., BOPs 60) located in the LMRP 30 and the lower BOP stack 10. In order to enable transmitting these signals, multiple electrical cables and/or hydraulic lines are used.

[0005] Several and varied feed-thru components may be used to carry some of the signals (including working fluids) between the LMRP 30 and the lower BOP stack 10. A MUX "pod" 70 is a subsea single mono-block feed-thru component attached to the LMRP 30 enabling transmission of a plurality of hydraulic control signals to the lower BOP stack 10.

[0006] The MUX "pod" 70 is detailed in Figure 2, showing a plurality of output ports 80 on wedge sides 75 (one

visible) of the MUX "pod" 70. When the LMRP 30 is engaged with the lower BOP stack 10, the MUX "pod" 70 is lowered to engage with a receiver plate 90 located on the lower BOP stack 10 such that the ports 80 on the wedge sides 75 communicate with ports 85 on a wedge side 95 of the receiver plate 90. The wedge side 90 of the receiver plate has a seal surface to prevent hydraulic fluid to leak outside intended channels, from the ports 80 to the ports 85.

[0007] A fluid port is an exit of a channel configured to enable a fluid communication between the LMRP 30 and the lower BOP stack 10, while engaged with each other. The size of the fluid ports may be in a range of 1/2" to 2" diameter depending on the functions they serve related to the devices in the lower BOP stack 10 towards the fluid is directed.

[0008] Any scratch occurring during transport or exploitation on the seal surface of the wedge 95 of the receiver plate 90, in the proximity of any fluid port 85 compromises the integrity of the seal, and, therefore, a seal function between the MUX "pod" 70 and the receiver plate 90. When the seal surface 95 of the receiver plate 90 is damaged, the repairs trigger costly downtime (e.g., rig downtime cost 500,000\$/day). A damaged seal surface may have to be machined. Weld repairs can be used, but their execution may distort the metal from which the receiver plate is made leading to additional downtime. Sometimes, the receiver plate 90 (which, for example, may weigh up to 500 lb and may have dimensions of 2 ft x 3 ft x 1/2 ft) has to be replaced.

[0009] Accordingly, it would be desirable to provide devices and methods that avoid the long and costly repairs of the seal surfaces.

SUMMARY

[0010] According to an exemplary embodiment a removable device useable for locally repairing a seal surface of a receiver plate is provided. The removable device includes a rigid portion is made of a material substantially similar to a material of the receiver plate, and is configured to be removably inserted in a fluid port of the receiver plate, the rigid portion having (i) a seal surface flushed with the seal surface of the receiver plate when the device is inserted in the fluid port, and (ii) a channel configured to allow a fluid communication. The removable device also includes a seal made of a rubber-like material and placed outside the rigid portion, and configured to prevent a fluid leak.

[0011] According to another exemplary embodiment, a receiver plate configured to engage with one or more removable devices having a seal surface is provided. The receiver plate has one or more channels configured to allow fluid to pass therethrough, and at least one fluid port formed at an end of a channel among the one or more fluid channels, the at least one fluid port being configured to receive a removable device. The receiver plate also includes a wedge seal surface (320) on which the

at least one or more fluid ports open to achieve a fluid communication, the wedge seal surface being configured to prevent fluid leak when the receiver plate is engaged with another wedge having a surface with one or more wedge fluid ports.

[0012] According to another exemplary embodiment, a method of repairing a receiver plate being damaged on a wedged seal surface with one or more fluid ports in an oil and gas installation is provided. The method includes mounting a removable device with a seal surface configured to flush with the wedged seal surface, the removable device being mounted inside a fluid port located in a damaged portion of the wedged seal surface. The method further includes machining the seal surface of the removable device and a portion of the wedged seal surface surrounding the fluid port.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013] The accompanying drawings, which are incorporated in and constitute a part of the specification, illustrate one or more embodiments and, together with the description, explain these embodiments. In the drawings:

[0014] Figure 1 is a schematic diagram of an offshore rig;

[0015] Figure 2 is a schematic diagram of a MUX pod;

[0016] Figure 3 is a schematic diagram of a receiver plate;

[0017] Figure 4 is a cross-section of a removable device according to an exemplary embodiment;

[0018] Figure 5 is a cross section in a receiver plate according to another exemplary embodiment;

[0019] Figure 6 is a cross section in a receiver plate having a removable device mounted therein according to another exemplary embodiment;

[0020] Figure 7 is a view of a portion of a seal surface of a receiver plate in which a removable device is inserted according to an exemplary embodiment; and

[0021] Figure 8 is a flow chart of a method of repairing a receiver plate having a damaged seal surface, according to an exemplary embodiment.

DETAILED DESCRIPTION

[0022] The following description of the exemplary embodiments refers to the accompanying drawings. The same reference numbers in different drawings identify the same or similar elements. The following detailed description does not limit the invention. Instead, the scope of the invention is defined by the appended claims. The following embodiments are discussed, for simplicity, with regard to the terminology and structure of a subsea oil and gas installation having seal surfaces with fluid ports interfacing detachable parts. However, the embodiments to be discussed next are not limited to these systems, but may be applied to other systems that require local repair of a seal surface around a fluid port at a low price and with a reduced repair time.

[0023] Reference throughout the specification to "one embodiment" or "an embodiment" means that a particular feature, structure, or characteristic described in connection with an embodiment is included in at least one embodiment of the subject matter disclosed. Thus, the appearance of the phrases "in one embodiment" or "in an embodiment" in various places throughout the specification is not necessarily referring to the same embodiment. Further, the particular features, structures or characteristics may be combined in any suitable manner in one or more embodiments.

Figure 4 illustrates a cross section across a removable device 200 according to an exemplary embodiment. The device 200 includes a rigid portion 210 and an O-ring 220 seal. The rigid portion 210 is made of a material similar with the material of a receiver plate in which the device is inserted (e.g., stainless steel). The O-ring 220 seal is made of a rubber-like material (e.g., an elastomer). In a non-limiting embodiment, the removable device 200 has a diameter D of about 1" and a length L of about 1.5". The O-ring seal 220 illustrated in Figure 4 is not intended to be limiting relative to the useable types of seals. Seals having other types of seals than the O-type may be used to prevent a fluid leak between the receiver plate and the removable device 200.

[0024] The rigid portion 210 has a tubular shape with a channel 212 substantially in the middle. When the LM-RP and the lower BOP stack are attached to each other, fluid from the MUX pod may circulate through the channel 212 towards devices in the BOP stack. Threads 214 are located on an outer surface of the rigid portion 210. The threads 214 have shapes complementary to threads in a fluid port of the receiver plate configured to receive the removable device 200. The threads 214 may be SAE threads (i.e., as standardized by Society of Automotive Engineers). A surface 216 of the rigid portion 210 aligns (flushes) with the seal surface of the receiving plate, when the removable device 200 is mounted in a corresponding fluid port of the receiving plate. At an end 218 of the rigid portion 210, opposite to the surface 216, a groove 219 is configured to accommodate the O-ring seal 220.

[0025] In order to accommodate one or more removable devices similar to the one illustrated in Figure 4, a receiver plate 300 (a cross section through a portion of which is illustrated in Figure 5) may be manufactured to have one or more fluid ports 310 substantially perpendicular to the wedged seal surface 320, along channels 340 configured to direct fluid towards devices in the lower BOP stack. Alternatively, in order to repair a seal surface around a fluid port on an existing receiver plate, a fluid port 310 may be drilled enlarging the existing port in order to enable receiving a removable device therein.

[0026] Threads 330 may be formed on at least a part of the inside surface of the fluid port 310 to configure the receiver plate 300 to receive the removable device 200 therein. The depth of the fluid port 310 is substantially equal to the length L of the removable device 200 to be mounted therein. The fluid port 310 may be configured

along a fluid channel 340, and emerges substantially perpendicular to the seal surface 320. The threads 330 have shapes complementary to shapes of threads 214 on an outer surface of the removable device 200 to be mounted in the fluid port 310.

[0027] Figure 6 is a cross section in a receiver plate 300 having a removable device 200 mounted therein. The threads 330 on the inner surface of the fluid port 310 in the receiver plate 300 are engaged with the threads 214 on the outer surface of the rigid portion 210 of the removable device 200. The surface 216 of the removable device 200 aligns (flushes) with the seal surface 320 of the receiver plate 300. The channel 340 in the receiver plate and the channel 212 of the removable device 200 may have substantially similar diameters and extend along the same axis 250.

[0028] Figure 7 is a view of a portion of a seal surface 320 of a receiver plate 300 in which a removable device 200 is inserted according to an embodiment. The seal surface 216 may align with the surface 320 in a manner that would require no other operation for completing the repair. However, the surface 216 of the removable device 200 and a part 260 of the seal surface 320 surrounding the surface 216 may be locally machined to improve the overall sealing quality.

[0029] Thus when a scratch affecting the seal related to a port 285 occurs in an area where a removable device is mounted, the device 200 is removed (e.g., un-screwed) and another similar device is inserted in the fluid port (e.g., 310). Alternatively, for a conventional receiving plate, when a scratch affecting sealing of a fluid port occurs, a fluid port with inner threads is formed to enable inserting of a removable device (e.g., 200) therein. Local machining of an area including the outer surface of the removable device and the surrounding part of the seal surface may be performed to ensure smoothness and, thus, enhancing the sealing quality of the seal surface after this repair.

[0030] By using removable devices with a seal surface to repair a seal surface, the downtime is shortened and the cost of the repair is reduced. Additionally, instead of machining the entire angled surface, machining may be performed only locally and smaller machines may be used. Another advantage is that since damaged areas are locally repairable, the need to replace the receiver plate occurs less frequently.

[0031] The flow chart of a method 400 of repairing a receiver plate having damage on a seal surface with one or more fluid ports is illustrated in Figure 5.

[0032] The method 400 includes mounting a removable device with a seal surface in a fluid port of the receiver plate such that the seal surface of the removable device substantially aligns with the seal surface of the receiving plate, at S410. The method 400 further includes machining an area including the seal surface of the removable device and a portion of the seal surface of the receiver plate, the portion surrounding the seal surface of the removable device, at S420.

[0033] If the receiving plate is a plate manufactured to have a fluid port in which a device with a seal surface is inserted, and a damaged portion of the seal surface includes the seal surface of the existing device, prior to S410, removing the existing device is performed. If the receiving plate is a conventional plate manufactured without a fluid port in which a device with a seal surface to be inserted, a fluid port configured to receive the device is formed, prior to S410.

[0034] The disclosed exemplary embodiments provide devices and methods for repairing seal surfaces of a receiver plate in a subsea oil and gas installation. It should be understood that this description is not intended to limit the invention. On the contrary, the exemplary embodiments are intended to cover alternatives, modifications and equivalents, which are included in the spirit and scope of the invention as defined by the appended claims. Further, in the detailed description of the exemplary embodiments, numerous specific details are set forth in order to provide a comprehensive understanding of the claimed invention. However, one skilled in the art would understand that various embodiments may be practiced without such specific details.

[0035] Although the features and elements of the present exemplary embodiments are described in the embodiments in particular combinations, each feature or element can be used alone without the other features and elements of the embodiments or in various combinations with or without other features and elements disclosed herein.

[0036] This written description uses examples of the subject matter disclosed to enable any person skilled in the art to practice the same, including making and using any devices or systems and performing any incorporated methods. The patentable scope of the subject matter is defined by the claims, and may include other examples that occur to those skilled in the art. Such other examples are intended to be within the scope of the claims.

[0037] Various aspects and embodiments of the present invention are defined by the following numbered clauses:

1. A removable device useable for locally repairing a seal surface of a receiver plate, the removable device comprising:

a rigid portion made of a material substantially similar to a material of the receiver plate, and configured to be removably inserted in a fluid port of the receiver plate, the rigid portion having (i) a seal surface flushed with the seal surface of the receiver plate when the device is inserted in the fluid port, and (ii) a channel configured to allow a fluid communication; and
a seal made of a rubber-like material and placed outside the rigid portion, the seal being configured to prevent a fluid leak.

2. The removable device of clause 1, wherein the rigid portion has a groove at an end of the rigid portion opposite to the seal surface of the rigid portion, the groove being configured to accommodate the seal.
3. The removable device of clause 1 or clause 2, wherein the seal is an O-ring seal.
4. The removable device of any preceding clause, wherein the seal is made of an elastomer.
5. The removable device of any preceding clause, wherein the rigid portion has threads on an outer surface that is substantially perpendicular to the seal surface, the threads having shapes complementary to shapes of threads inside the fluid port of the receiver plate.
6. A receiver plate configured to engage with one or more removable devices having a seal surface, the receiver plate comprising:
- one or more channels configured to allow fluid to pass therethrough;
 - at least one fluid port formed at an end of a channel among the one or more fluid channels, the at least one fluid port being configured to receive a removable device; and
 - a wedge seal surface on which the at least one or more fluid ports open to achieve a fluid communication, the wedge seal surface being configured to prevent fluid leak when the receiver plate is engaged with another wedge having a surface with one or more wedge fluid ports.
7. The receiver plate of any preceding clause, wherein threads are formed on walls of the at least one fluid port, the threads having shapes complementary to shapes of threads on an outer surface of the removable device to be inserted in the at least one fluid port.
8. The receiver plate of any preceding clause, wherein the at least one fluid port is formed to be substantially perpendicular to the wedge seal surface.
9. The receiver plate of any preceding clause, further comprising one or more fluid ports each of which being formed at an end of a channel among the one or more channels, and being configured to allow a removable device to be inserted in the one or more fluid ports to locally repair the wedge seal surface, the one or more fluid ports including the at least one fluid port, and a fluid port being formed for each of the one or more channels.
10. The receiver plate of any preceding clause, wherein the one or more channels include at least two channels with different diameters.
11. The receiver plate of any preceding clause, further comprising:
- a removable device removably inserted in the at least one fluid port of the receiver plate, the removable device including

a rigid portion made of a material substantially similar to a material of the receiver plate, and having (i) a seal surface flushed with the wedge seal surface of the receiver plate when the removable device is inserted in the at least one fluid port, and (ii) a channel of the removable device aligned with the channel of the receiver plate; and

a seal made of a rubber-like material, which is placed outside the rigid portion, the seal being configured to prevent a fluid leak between the rigid portion and the at least one fluid port.

12. The receiver plate of any preceding clause, wherein the seal is an O-ring seal.
13. The receiver of any preceding clause, wherein the rigid portion has a groove at an end of the rigid portion opposite to the seal surface of the rigid portion, the groove being configured to accommodate the seal.
14. The receiver of any preceding clause, wherein the rigid portion is made of a material substantially similar to a material of the receiver plate.
15. A method of repairing a receiver plate being damaged on a wedged seal surface with one or more fluid ports in an oil and gas installation, the method comprising:
- mounting a removable device with a seal surface configured to flush with the wedged seal surface of the receiver plate, the removable device being mounted inside a fluid port located in a damaged portion of the wedged seal surface; and
 - machining the seal surface of the removable device and a portion of the wedge seal surface surrounding the fluid port.

16. The method of clause 15, further comprising:

- removing an existing removable device from the fluid port.

17. The method of clause 15 or clause 16, further comprising:

- forming the fluid port to be able to receive the removable device, when the fluid port has not been configured to receive the removable device.

18. The method of any of clauses 15 to 17, wherein the removable device includes a seal made of a rubber-like material, and a rigid portion, and the mounting of the removable device includes placing the seal between the rigid portion and the fluid port to prevent a fluid leak.

19. The method of any of clauses 15 to 18, wherein the fluid port extends into a channel inside the re-

ceiver plate, and the removable device includes a rigid portion with an open channel, and the mounting of the removable device includes fluidly connecting the channel inside the receiver plate and the open channel.

20. The method of any of clauses 15 to 19, wherein the removable device includes a rigid portion having outer threads and the fluid port has inner threads with shapes complementary to shaper of the outer threads of the rigid portion, and the mounting of the removable device includes engaging the outer treads with the inner threads.

Claims

1. A removable device useable for locally repairing a seal surface of a receiver plate, the removable device comprising:

a rigid portion made of a material substantially similar to a material of the receiver plate, and configured to be removably inserted in a fluid port of the receiver plate, the rigid portion having (i) a seal surface flushed with the seal surface of the receiver plate when the device is inserted in the fluid port, and (ii) a channel configured to allow a fluid communication; and
a seal made of a rubber-like material and placed outside the rigid portion, the seal being configured to prevent a fluid leak.

2. The removable device of claim 1, wherein the rigid portion has a groove at an end of the rigid portion opposite to the seal surface of the rigid portion, the groove being configured to accommodate the seal.
3. The removable device of claim 1 or claim 2, wherein the seal is an O-ring seal.
4. The removable device of any preceding claim, wherein the seal is made of an elastomer.
5. The removable device of any preceding claim, wherein the rigid portion has threads on an outer surface that is substantially perpendicular to the seal surface, the threads having shapes complementary to shapes of threads inside the fluid port of the receiver plate.
6. A receiver plate configured to engage with one or more removable devices having a seal surface, the receiver plate comprising:

one or more channels configured to allow fluid to pass therethrough;
at least one fluid port formed at an end of a channel among the one or more fluid channels, the

at least one fluid port being configured to receive a removable device; and
a wedge seal surface on which the at least one or more fluid ports open to achieve a fluid communication, the wedge seal surface being configured to prevent fluid leak when the receiver plate is engaged with another wedge having a surface with one or more wedge fluid ports.

7. The receiver plate of claim 6, wherein threads are formed on walls of the at least one fluid port, the threads having shapes complementary to shapes of threads on an outer surface of the removable device to be inserted in the at least one fluid port.
8. The receiver plate of claim 6 or claim 7, wherein the at least one fluid port is formed to be substantially perpendicular to the wedge seal surface.
9. The receiver plate of any of claims 6 to 8, further comprising one or more fluid ports each of which being formed at an end of a channel among the one or more channels, and being configured to allow a removable device to be inserted in the one or more fluid ports to locally repair the wedge seal surface, the one or more fluid ports including the at least one fluid port, and a fluid port being formed for each of the one or more channels.
10. The receiver plate of any of claims 6 to 9, wherein the one or more channels include at least two channels with different diameters.
11. The receiver plate of any of claims 6 to 10, further comprising:
a removable device removably inserted in the at least one fluid port of the receiver plate, the removable device including
a rigid portion made of a material substantially similar to a material of the receiver plate, and having (i) a seal surface flushed with the wedge seal surface of the receiver plate when the removable device is inserted in the at least one fluid port, and (ii) a channel of the removable device aligned with the channel of the receiver plate; and
a seal made of a rubber-like material, which is placed outside the rigid portion, the seal being configured to prevent a fluid leak between the rigid portion and the at least one fluid port.
12. The receiver plate of any of claims 6 to 11, wherein the seal is an O-ring seal.
13. The receiver of any of claims 6 to 12, wherein the rigid portion has a groove at an end of the rigid portion opposite to the seal surface of the rigid portion, the

groove being configured to accommodate the seal.

14. The receiver of any of claims 6 to 13, wherein the rigid portion is made of a material substantially similar to a material of the receiver plate. 5

15. A method of repairing a receiver plate being damaged on a wedged seal surface with one or more fluid ports in an oil and gas installation, the method comprising: 10

mounting a removable device with a seal surface configured to flush with the wedged seal surface of the receiver plate, the removable device being mounted inside a fluid port located in a damaged portion of the wedged seal surface; and 15
machining the seal surface of the removable device and a portion of the wedge seal surface surrounding the fluid port.

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Figure 1
(Background Art)

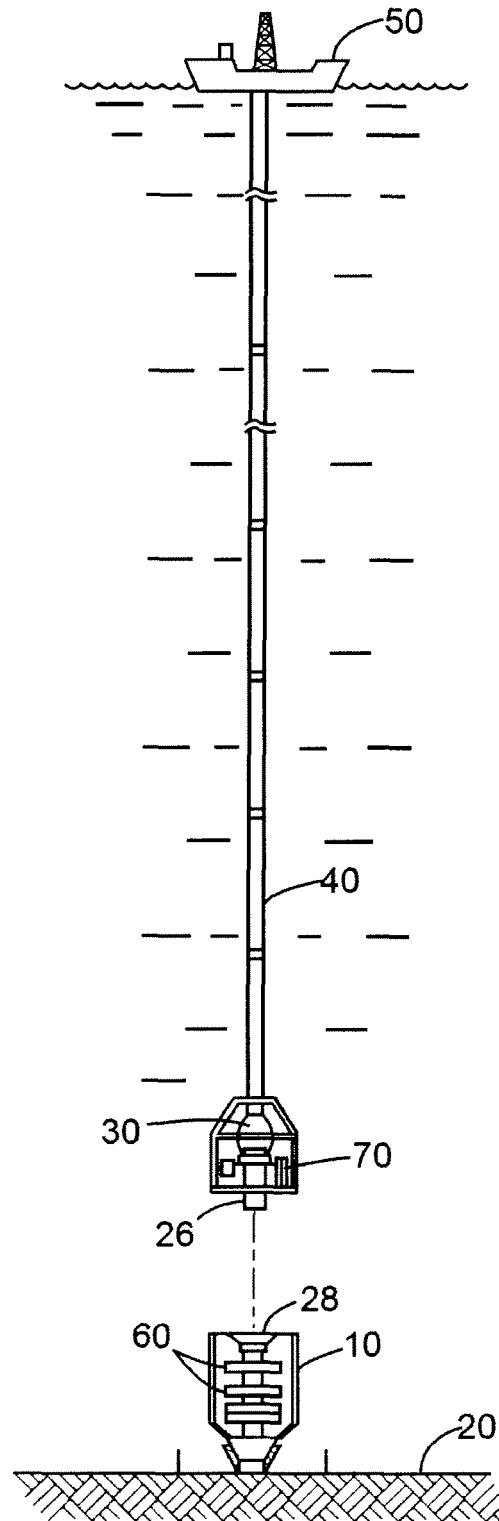


Figure 2
(Background Art)

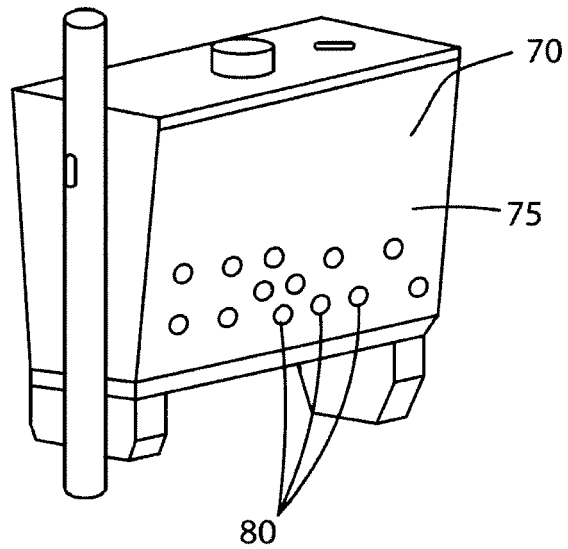


Figure 3
(Background Art)

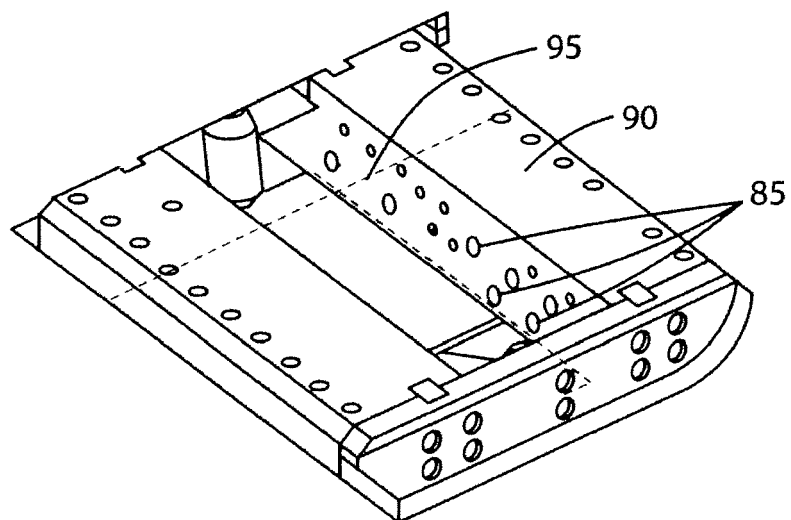


Figure 4

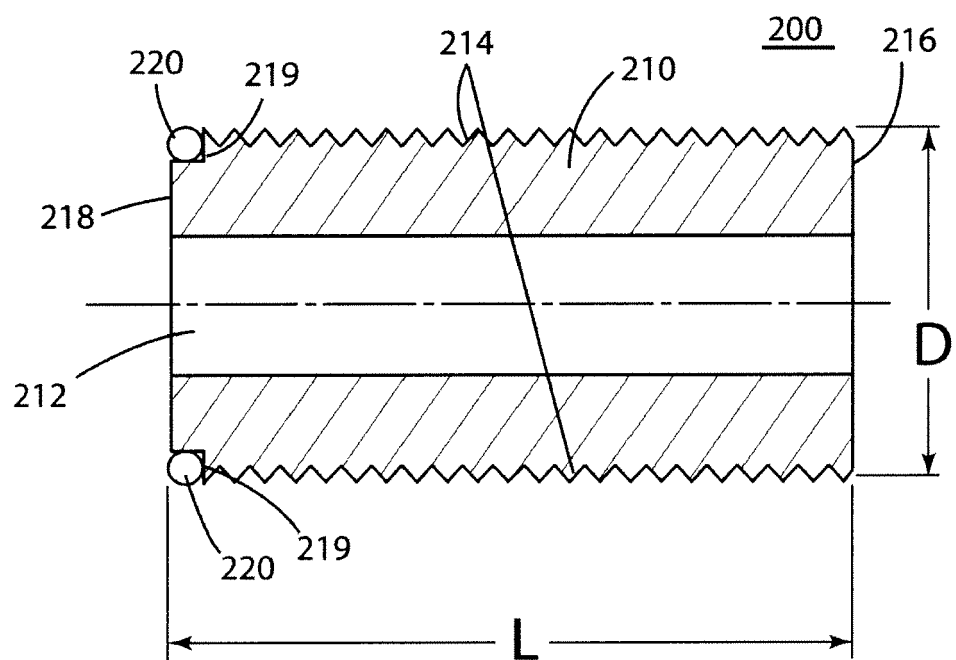


Figure 5

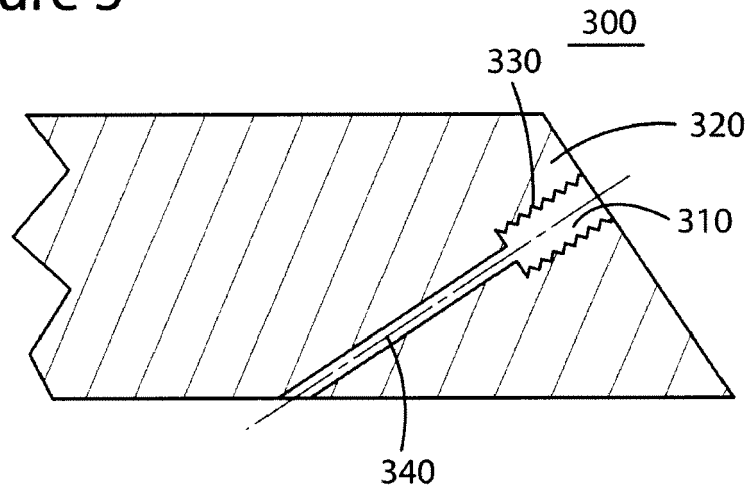


Figure 6

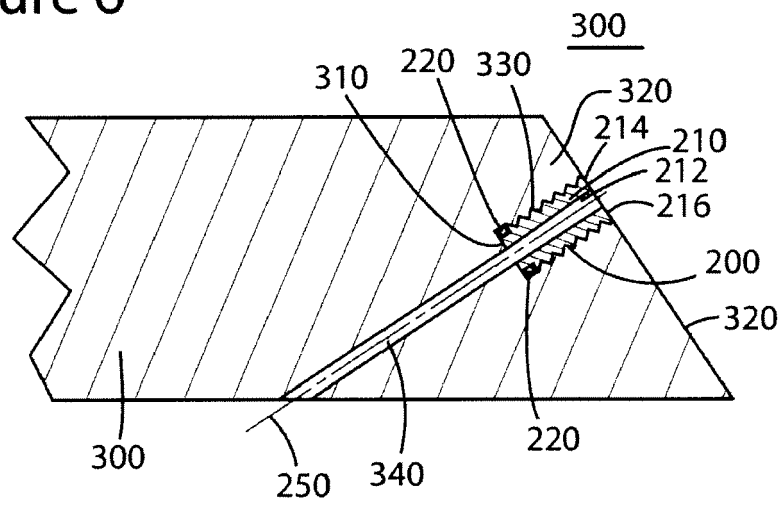


Figure 7

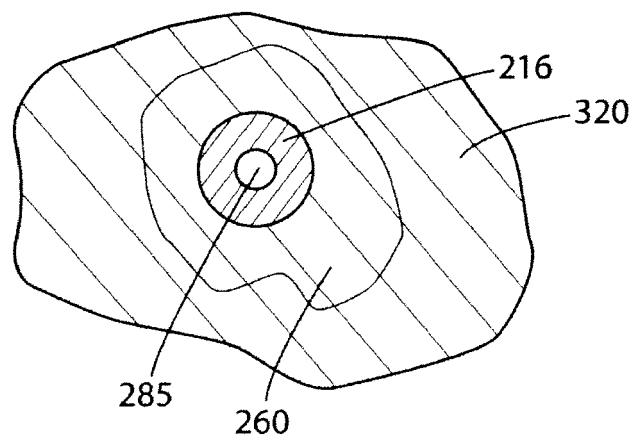


Figure 8

