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(54) CABLE MONITORING APPARATUS

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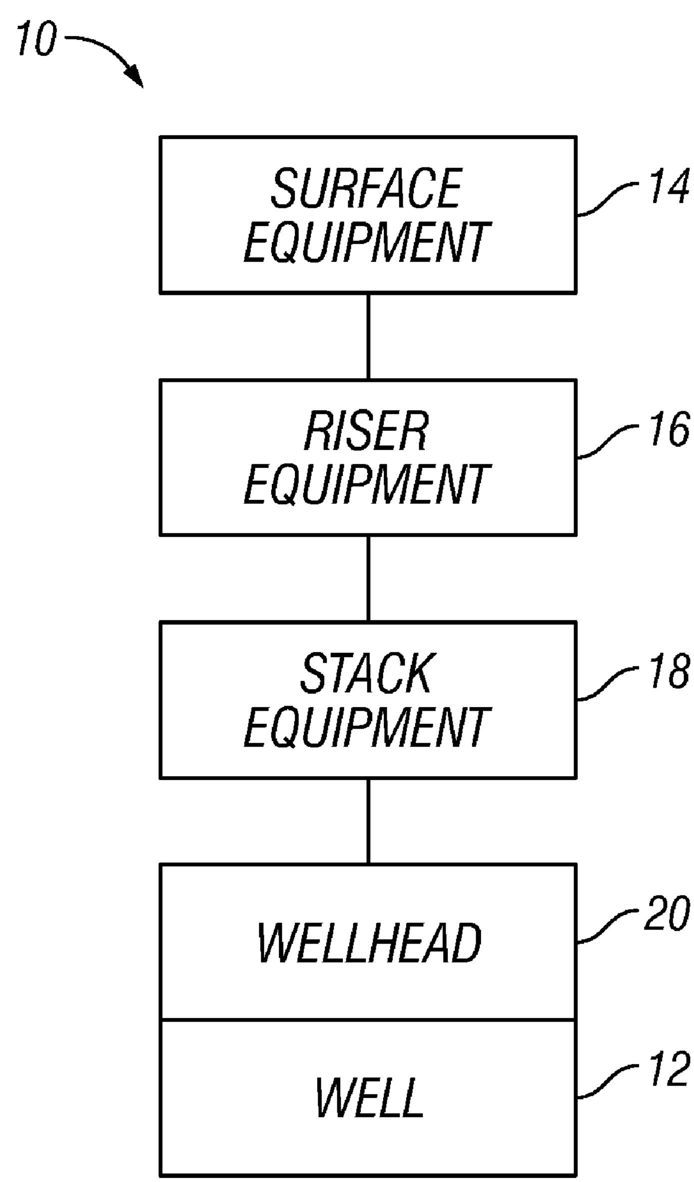
(57) ABSTRACT

A monitoring apparatus is connectable in-line with the cable. The monitoring apparatus includes a measuring unit to measure a characteristic of the cable and a storage unit to store the measured characteristic of the cable.



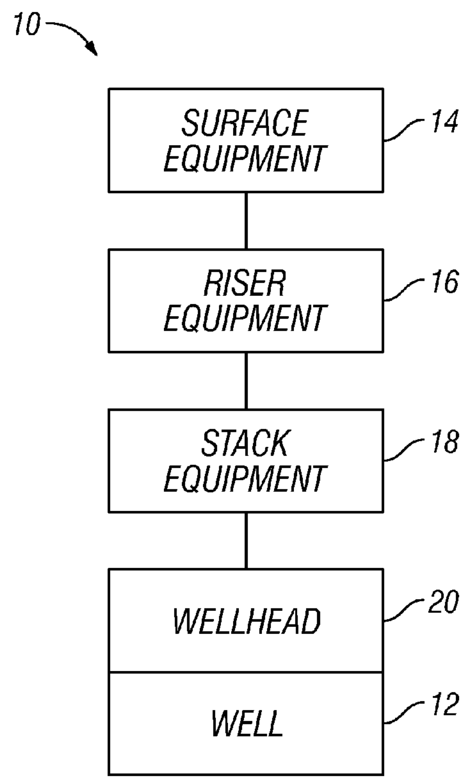


FIG. 1

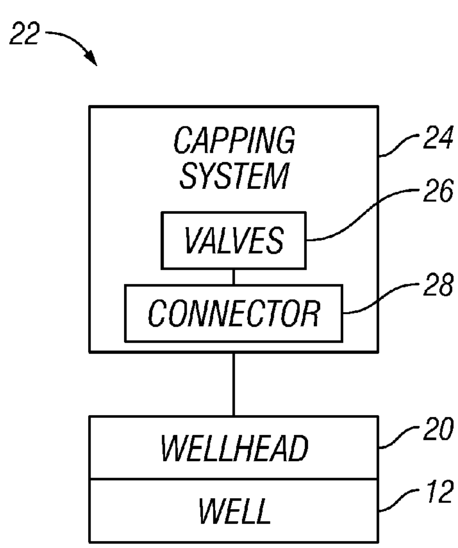


FIG. 2A

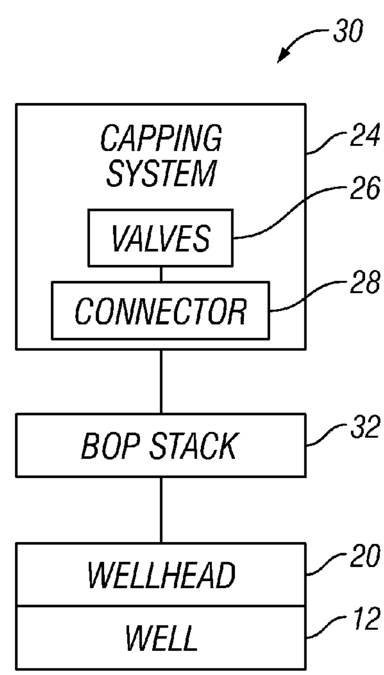


FIG. 2B

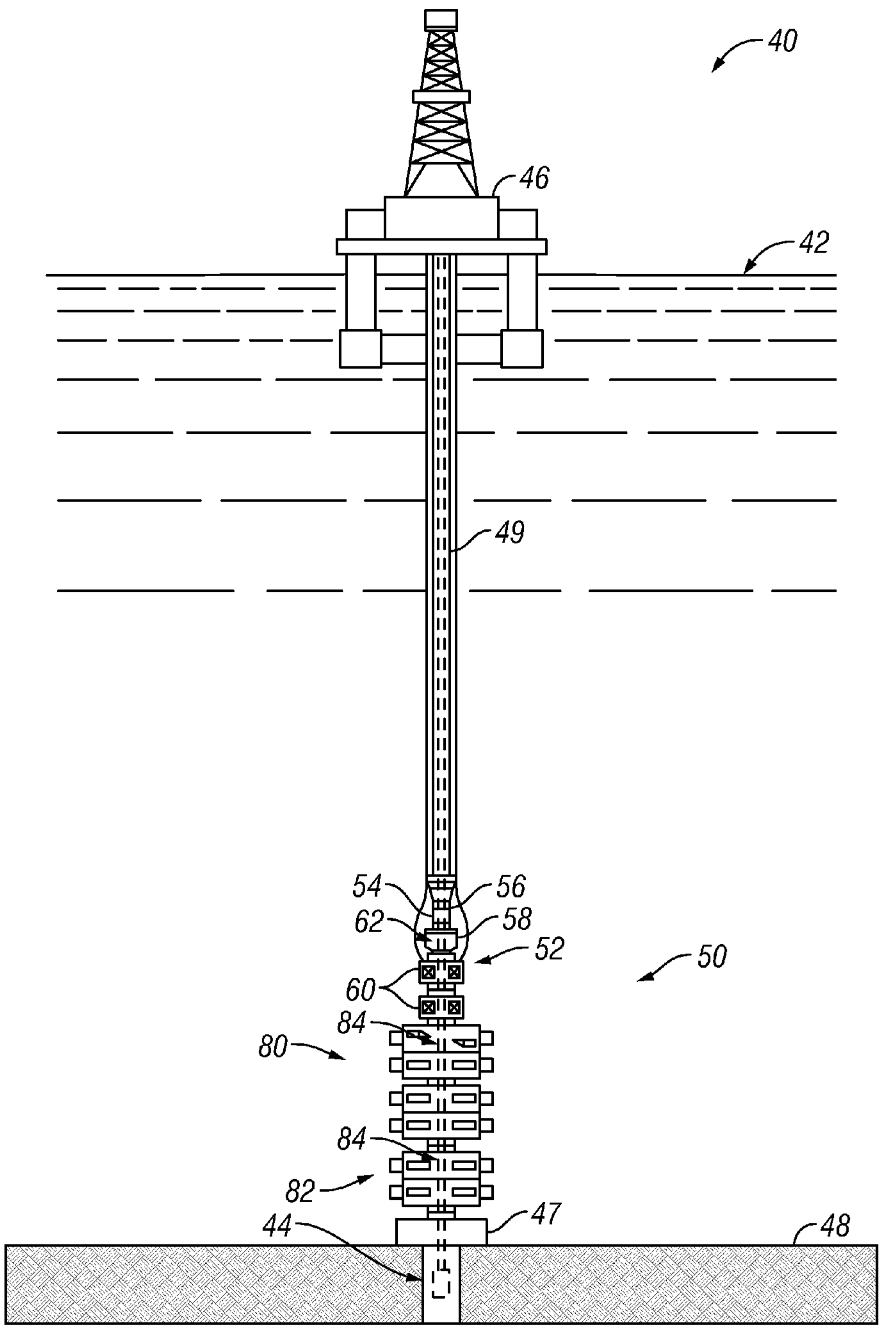


FIG. 3

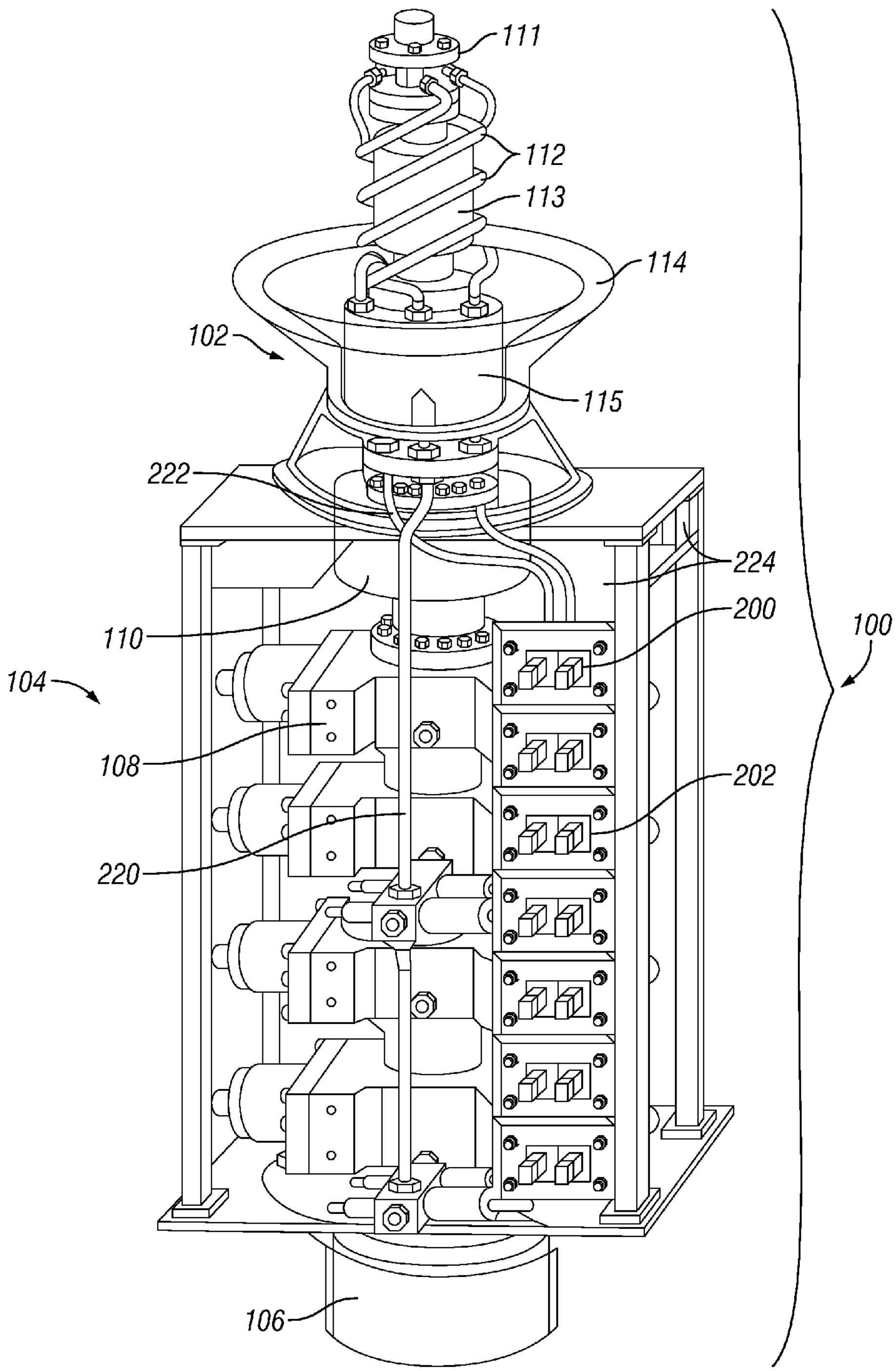


FIG. 4

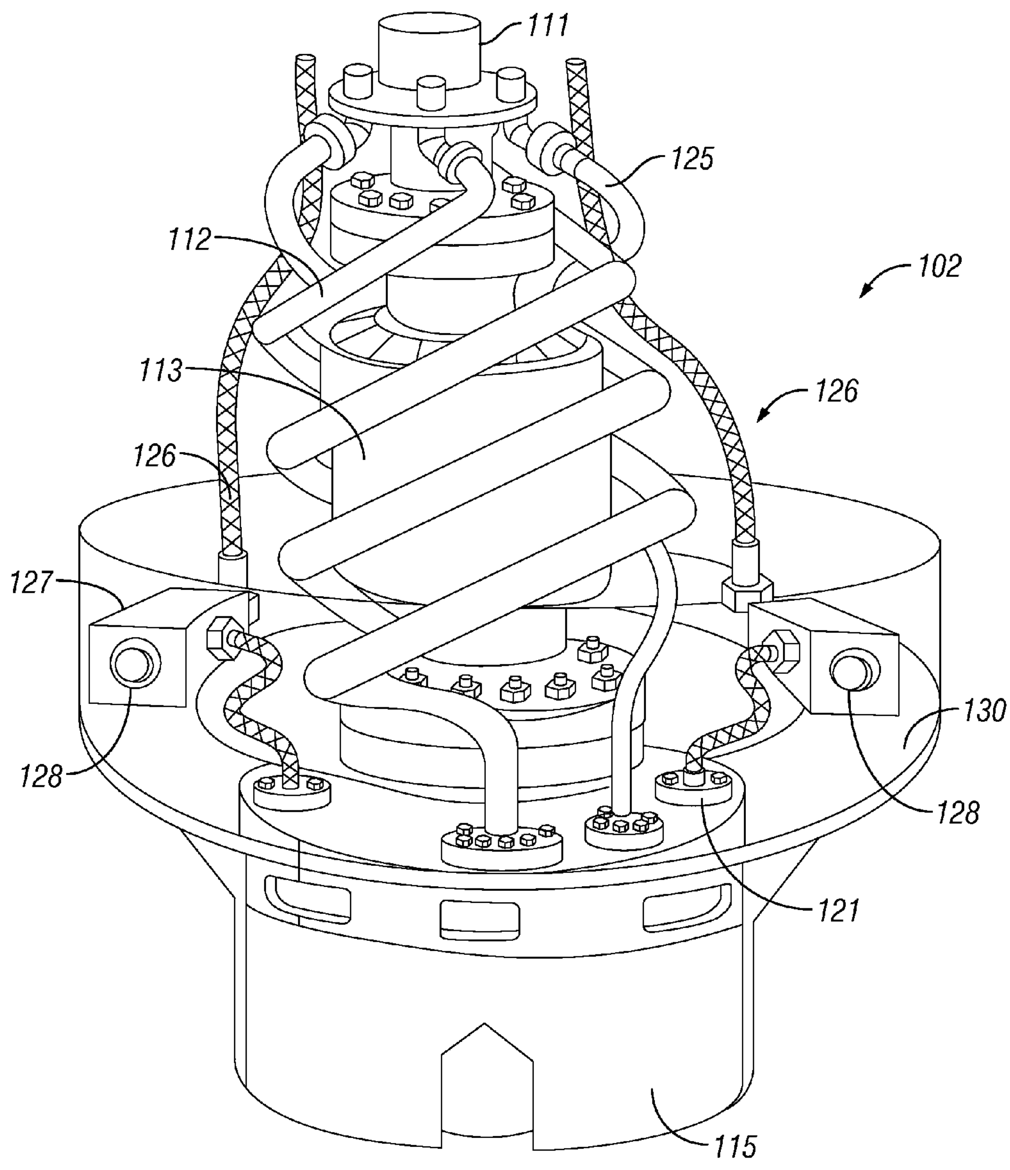


FIG. 5

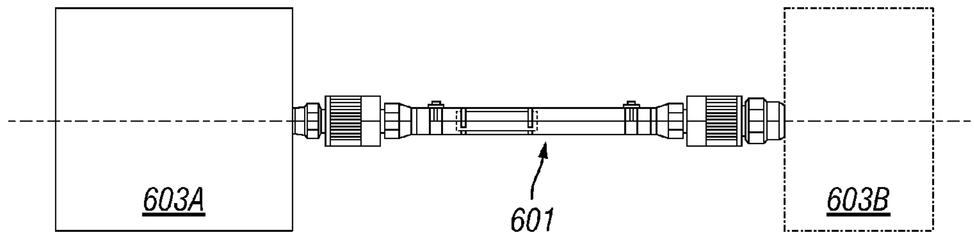


FIG. 6

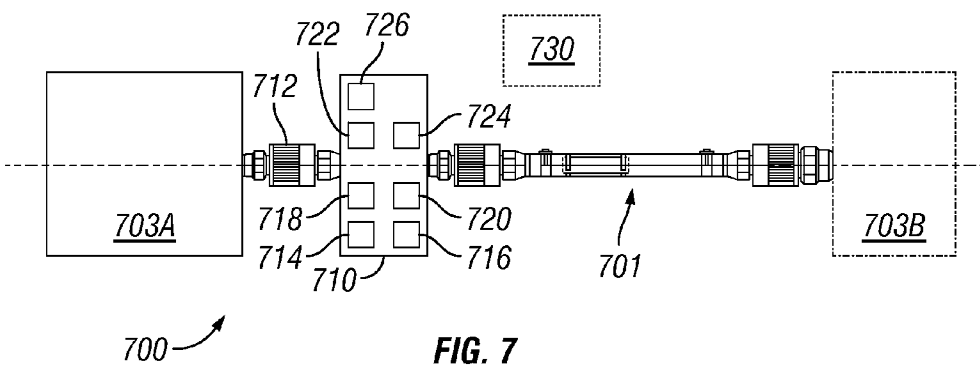


FIG. 7

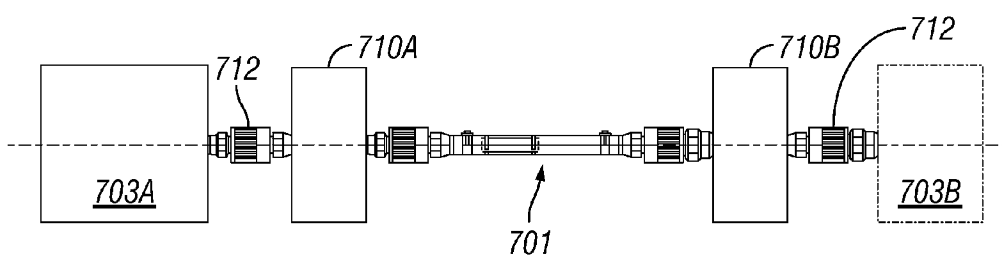


FIG. 8

CABLE MONITORING APPARATUS

[0001] BACKGROUND

[0002] This section is intended to introduce the reader to various aspects of art that may be related to various aspects of the presently described embodiments. 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 embodiments. Accordingly, it should be understood that these statements are to be read in this light, and not as admissions of prior art.

[0003] In order to meet consumer and industrial demand for natural resources, companies often invest significant amounts of time and money searching for and extracting oil, natural gas, and other subterranean resources from the earth. Particularly, once a desired subterranean resource is discovered, drilling and production systems are often employed to access and extract the resource. These systems may be located onshore or offshore depending on the location of a desired resource. Further, such systems generally include a wellhead assembly through which the resource is extracted. These wellhead assemblies may include a wide variety of components, such as various casings, valves, fluid conduits, and the like, that control drilling or extraction operations.

[0004] More particularly, wellhead assemblies typically include and connect to pressure-control equipment, such as a blowout preventer, to help control the flow of fluid (e.g., oil or natural gas) from a well. As will be appreciated, uncontrolled releases of oil or gas from a well via the wellhead assembly (also referred to as a blowout) are undesirable. Further, components and equipment in use with and coupled to the wellhead assembly benefits from robust design, to reduce the likelihood that oil or gas may be unintentionally released through these other components. As such, as there are numerous manufacturers for these components and equipment, in addition to the wellhead assemblies and blowout preventers themselves, measures are taken to help ensure that all of the equipment in use and the connections between the equipment are robust and field ready.

BRIEF DESCRIPTION OF THE DRAWINGS

[0005] For a detailed description of the preferred embodiments of the present disclosure, reference will now be made to the accompanying drawings in which:

[0006] FIG. **1** shows a block diagram of a resource extraction system in accordance with one or more embodiments of the present disclosure;

[0007] FIGS. **2**A and **2**B generally show a coupling of a well capping system to a wellhead in accordance with one or more embodiments of the present disclosure;

[0008] FIG. **3** is a schematic view of an embodiment of an offshore system for drilling and/or producing a subterranean wellbore in accordance with one or more embodiments of the present disclosure;

[0009] FIG. **4** shows a subsea blowout preventer stack in accordance with one or more embodiments of the present disclosure;

[0010] FIG. **5** shows a riser connector in accordance with one or more embodiments of the present disclosure;

[0011] FIG. **6** shows a system including a cable to communicate power and/or data between electronic components in accordance with one or more embodiments of the present disclosure;

[0012] FIG. **7** shows a system to monitor a condition of a cable in accordance with one or more embodiments of the present disclosure; and

[0013] FIG. **8** shows a system to monitor a condition of a cable in accordance with one or more embodiments of the present disclosure.

DETAILED DESCRIPTION

[0014] The following discussion is directed to various embodiments of the present disclosure. 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. Although one or more of these embodiments may be preferred, 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 exemplary of that embodiment, and not intended to intimate that the scope of the disclosure, including the claims, is limited to that embodiment.

[0015] 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. The drawing figures are not necessarily to scale. Certain features and components herein may be shown exaggerated in scale or in somewhat schematic form and some details of conventional elements may not be shown in interest of clarity and conciseness.

[0016] 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.

[0017] Reference throughout this specification to "one embodiment," "an embodiment," or similar language means that a particular feature, structure, or characteristic described in connection with the embodiment may be included in at least one embodiment of the present disclosure. Thus, appearances of the phrases "in one embodiment," "in an embodiment," and similar language throughout this specification may, but do not necessarily, all refer to the same embodiment.

[0018] Turning now to the present figures, a resource extraction system **10** is illustrated in FIG. **1** in accordance with one or more embodiments of the present disclosure. Notably, the system **10** facilitates extraction of a resource, such as oil or natural gas, from a well **12**. As depicted, the system **10** may be a subsea system that includes surface equipment **14**, riser equipment **16**, and/or stack equipment **18**, for extracting the resource from the well **12** via a wellhead **20**. In one subsea resource extraction application, the surface equipment **14** may be mounted to a drilling rig above the surface of the water, the stack equipment **18** may be coupled to the wellhead **20** near the sea floor, and the surface equipment **14** and the stack equipment **18** may be coupled to one another via the riser equipment **16**.

[0019] As will be appreciated, the surface equipment **14** may include a variety of devices and systems, such as pumps, power supplies, cable and hose reels, control units, a diverter, a gimbal, a spider, and the like. Similarly, the riser equipment **16** may also include a variety of components, such as riser joints, fill valves, control units, and a pressure-temperature transducer, to name but a few. The riser equipment **16** may facilitate transmission of the extracted resource to the surface equipment **14** from the stack equipment **18** and the well **12**. The stack equipment **18**, in turn, may include a number of components, such as blowout preventers, production trees (also known as "Christmas" trees), and the like for extracting the desired resource from the wellhead **20** and transmitting the resource to the surface equipment **14** via the riser equipment **16**.

[0020] In one or more embodiments, if a blowout occurs at a well, a capping system may be used in some instances to seal the well and reestablish control. Examples of the use of such capping systems are provided in FIGS. **2**A and **2**B. In one embodiment of the present disclosure represented by a block diagram **22** in FIG. **2**A, a capping system **24** may be attached to the wellhead **20** (such as following removal of the stack equipment **18** from the wellhead **20**). The capping system **24** may include one or more valves **26**, such as a blowout preventer, for controlling flow from the wellhead **20**. The capping system **24** may also include an adapter or connector **28** that facilitates connection of the capping system **24** onto the wellhead **20**. When not in use, the capping system **24** may be kept on "stand-by" as safety equipment for responding to a blowout. And though the capping system **24** may be used with subsea well installations, it is noted that the capping system **24** may also be used with other well installations (e.g., equipment of surface wells).

[0021] Referring now to FIG. **3** as another example, an embodiment of an offshore system **40** for drilling and/or producing a wellbore **44** in accordance with one or more embodiments of the present disclosure is shown. In this embodiment, system **40** includes an offshore vessel or platform **46** at the sea surface **42** and a subsea BOP stack assembly **50** mounted to a wellhead **47** at the sea floor **48**. The BOP stack assembly **50** is mounted to wellhead **47** and is designed and configured to control and seal wellbore **44**, thereby decreasing the risk of an unintended release of hydrocarbon fluids (liquids and gases). In this embodiment, the BOP stack assembly **50** may include a lower marine riser package (LMRP) **52**, a primary BOP or BOP stack **80**, and a secondary BOP or BOP stack **82**, with a main bore **84** extending therethrough. The LMRP **52** may include a riser flex joint **56**, a riser adapter **54**, an annular BOP **58**, and a pair of redundant control units or pods **60**. A flow bore **62** extends through the LMRP **52** from a riser **49** at the upper end of the LMRP **52** to a connection at the lower end of the LMRP **52**. The riser adapter **54** extends upward from the flex joint **56** and is coupled to the lower end of the riser **49**. The flex joint **56** allows the riser adapter **54** and the riser **49** connected thereto to deflect angularly relative to the LMRP **52** while wellbore fluids flow from the wellbore **44**, through the BOP stack assembly **50**, into the riser **49**. The secondary BOP stack **82** serves as a backup to the primary BOP stack **80** and the LMRP **52** in the event the primary BOP stack **80** and/or the LMRP **52** fail, malfunction, or lose control communication with the vessel **46**. Accordingly, the secondary BOP stack **82** may also be referred to as a backup BOP stack or a BOP stack of last resort.

[0022] Referring now to FIG. **4**, a subsea blowout preventer stack (BOP stack) **100** in accordance with one or more embodiments of the present disclosure is shown. Variations of the architecture and components of modular retrievable element control system **200** may be utilized subsea, e.g. in production tree, production riser, and subsea manifold control interface applications. In one or more embodiments, the BOP stack **100** may include a riser connector **102**, a BOP assembly **104**, and a wellhead connector **106**.

[0023] The BOP assembly **104** may accept and allow the use of distributed functional control modules **200** that are remotely operated vehicle (ROV) retrievable. The use of the distributed functional control modules **200**, and/or the modular distributed control system architecture, in subsea BOP Stack applications may allow for the re-configuration of existing BOP stack arrangement designs to reduce weight and complexity in the integration and unitization of the elements required to form the overall BOP stack **100**.

[0024] The BOP assembly **104** may be unitized and include one or more of the following elements, such as the hydraulic connector **106** to interface to the subsea wellhead, one or more blowout preventers **108** (e.g. ram type blowout preventers), annular **110** or spherical type blowout preventers, a plurality of hydraulic connectors to interface to a marine riser (not shown in the figures), and/or hydraulically operated gate type valves for isolation and access for choke and kill functions. The riser connector **102** may include one or more of the following, such as a riser adapter **111**, a guideline-less reentry assembly **114**, and a multi-bore connector **115**. A flex joint **113** may be positioned intermediate the riser adapter **111** and the multi-bore connector **115**. One or more flex loops **112** may be present and in fluid communication with ports on the riser adapter **111**. The multi-bore connector **115** may provide an interface to the BOP assembly **104**.

[0025] The BOP assembly **104** may be further adapted to receive one or more control modules **200** into one or more docking stations **202** and/or other modules, e.g. the annular preventer **110**, the RAM preventer **108**, the blowout preventers (not specifically shown), connectors (not specifically shown), "Fail Safe" gate valves (not specifically shown), sub system interface valves (not specifically shown), or the like, or combinations thereof. One or more lines **220**, e g kill and/or choke lines, may be present as well as various control pathways, such as hydraulic conduit **222** and/or multiplexer (MUX) cables. Hang-off beams **224** may also be provided to allow for support of BOP assembly **104** during certain operations, e.g. in a moon pool area such as for staging and/or testing prior to running.

[0026] Referring now to FIG. **5**, a riser connector **102** may be adapted to provide a connector, such as riser adapter **111**, to interface with a marine riser (not shown in FIG. **5**). In one embodiment, the riser connector **102** may include one or more MUX cables **126** and/or one or more hydraulic conduit hoses **125**. The riser connector **102** may also incorporate integral connection receptacles for choke/kill, hydraulic, electric, and boost line conduit interfaces. In one embodiment, the riser connector **102** is configured with connector **115** as a multi-bore connector rather than single bore connector, although either configuration may be used. This may allow for the riser connector **102** to absorb loading and separating forces, as well as bending moments, within the body where substantial section modulus exists. Further, this configuration may decrease the need for a substantial fabricated structure to alleviate the potential for separation of a line holding a high pressure, e.g. line **220** (FIG. **4**).

[0027] In one embodiment, one or more subsea wet mateable connectors **121** may be included within the riser connector **102** for interfacing with the BOP assembly **104** (FIG. **4**). For example, this interface may be used to supply power and/or communications to the control modules **200** (FIG. **4**) included on the BOP assembly **104**. The riser connector **102** may also include a riser connector control module **128**, which may include and/or be integral with a junction box **127** and/or a subsea electronics module. The riser connector control module **128** may allow control of the riser connector **102**, and a lower marine riser package may function independent of the BOP stack **100** (FIG. **4**) in the event the marine riser is disconnected from the BOP stack **100** and pulled back to the surface.

[0028] The subsea electronics module **127** may provide for connections, such as electrical connections, and may be equipped with connector receptacles for interfacing to ROV devices, e.g. ROV retrievable control modules **200** (FIG. **4**) to facilitate control of riser connector functions. As such, the subsea electronics module **127** may provide one or more interfaces from the multiplex cables **126** to a lower marine riser package that includes the multibore riser connector **115**. As such, in one or more embodiments, the multiplex cables **126** may include pressure balanced oil-filled cables.

[0029] An apron plate **130** may be provided for mounting the junction boxes **127**, such as to provide a transition from main multiplex control cable connectors to the wet mateable assemblies located in the multi-bore connector **115**. Power and other signals to the riser connector control module **128** may be provided, such as by using one or more pressure balanced oil-filled cables connected to the electrical junction boxes **127** mounted on the apron plate **130**. In one embodiment, two junction boxes **127** may be provided for redundancy and each may be distinguished from the other, e.g. labeled or provided with different colors. The riser connector **102** may include the flex joint **113** and one or more flex loops **112**, such as to allow for angular movement to compensate for vessel offset. The upper flange adapter or flex joint top connection may interface to a flange of riser adapter **111** containing kick-out flanged assemblies for connection of lines **220** (FIG. **4**) interfacing with the marine riser, e.g. formed hard pipe flow-loops that interface choke and kill line **220** to the main marine riser.

[0030] Referring now to FIG. **6**, an embodiment is shown in which a cable **601**, such as a pressure balanced oil-filled cable, is used to communicate power and/or data between electronic components and/or housings **603**A and **603**B. For example, the electronic components **603**A and **603**B may be included within a subsea resource extraction system. In such an embodiment, one and/or both of the electronic components **603**A and **603**B may include a subsea electronics module and/or a riser control box.

[0031] Referring now to FIG. **7**, a system **700** to monitor a condition of a cable **701** in accordance with one or more embodiments of the present disclosure is shown. The cable **701** may be used to communicate power and/or data between electronic components and/or housings **703**A and **703**B. The cable **701** may be a pressure balanced oil-filled cable, such as shown in this embodiment, and/or may be any other cable capable of transferring power and/or data. One and/or both of the electronic components **703**A and **703**B may include a subsea electronics module and/or a riser control box, and/or any other component discussed above with respect to FIGS. **1-6**.

[0032] Further, as shown, the system **700** may include a monitoring apparatus **710**. The monitoring apparatus **710** may be used to monitor one or more conditions and/or components of the cable **701**, such as to determine if and when the cable **701** may need to be replaced within the system **700**. In this embodiment, the monitoring apparatus **710** may be connectable in-line with the cable **701**, such as connectable in series with the cable **701**. In another embodiment, the monitoring apparatus **710** may be connectable in parallel with the cable **701**.

[0033] The condition of the cable **701** may degrade and fail due to several factors, particularly in a pressurized subsea environment, such as degradation of the insulation resistance of the cable **701**, fluid ingress into the cable **701**, and/or external impacts experienced by the cable **701**. In one embodiment, the monitoring apparatus **710** may be used to monitor a condition of one or more data conductors and/or one or more power conductors included within the cable **701**. The monitoring apparatus **710** may then be able to determine if one or more data conductors and/or one or more power conductors has degraded and/or failed.

[0034] As the monitoring apparatus **710** may be used to monitor the conditions and/or components of the cable **701**, the monitoring apparatus **710** may be directly connected to one of the ends of the cable **701**, as shown. This may enable the monitoring apparatus **710** to send signals into and/or receive signals from the cable **701** without interference of other components therebetween. As the monitoring apparatus **710** may be introduced into the system **700** between the electronic components **703**A and **703**B, an adapter **712** may also be included within the system **700**. The adapter **712** may be included between the monitoring apparatus **710** and the electronic component **703**A, such as to establish electronic communication between the electronic components **703**A and **703**B through the cable **701**, the monitoring apparatus **710**, and the adapter **712**.

[0035] The monitoring apparatus **710** may include one or more units, such as formed separately or together, to facilitate monitoring the conditions and/or components of the cable **701**. For example, as shown in FIG. **7**, the monitoring apparatus **710** may include a measuring unit **714**, a storage unit **716**, and/or an output unit **718**. The measuring unit **714** may be used to measure a characteristic of the cable **701** based upon a signal sent into the cable **701** and/or received from the cable **701**. For example, the measuring unit **714** may be able to measure one or more of the following characteristics of the cable **701** and/or components of the cable **701**, including, but not limited to: impedance, resistance, capacitance, inductance, propagation speed, propagation delay, and delay skew related to the cable.

[0036] In one or more embodiments, the measuring unit **714** may measure one or more characteristics of the cable

701, in which the measuring unit **714** and/or another unit (e.g., a determining unit **726**) of the monitoring apparatus **710** may compare the measured characteristic of the cable **701** with a predetermined value and/or predetermined range for the measured characteristic. Based upon this comparison, the measuring unit **714** and/or another unit (e.g., the determining unit **726**) of the monitoring apparatus **710** may determine the condition of the cable **701**, such as if the cable **701** is acceptable for service and/or needs replacing. For example, the resistance of the cable **701** may be a characteristic that may be measured by the measuring unit **714** of the monitoring unit **710**. If the measured resistance of the cable **701** is above a predetermined value, and/or is not within a predetermined range, then the condition of the cable **701** may be determined to need service and/or replacement. Additionally or alternatively, the propagation delay of the cable **701** may be a characteristic that may be measured by the measuring unit **714** of the monitoring unit **710**. If the measured propagation delay of the cable **701** is above a predetermined value, and/or is not within a predetermined range, then the condition of the cable **701** may be determined to need service and/or replacement. The condition of the cable **701** may be determined to need service and/or replacement due to several factors, such as degradation of insulation resistance of the cable **701**, fluid ingress into the cable **701**, and/or external impacts to the cable **701**.

[0037] In one embodiment, the monitoring apparatus **710** may give an evaluation that indicates that the condition of the cable is good (e.g., monitoring apparatus **710** indicates a green light), the condition of the cable is satisfactory but close to replacement (e.g., monitoring apparatus **710** indicates a yellow light), and/or the condition of the cable is in need of replacement (e.g., monitoring apparatus **710** indicates a red light).

[0038] The storage unit **716** may be used to store the measured characteristic of the cable **701**. For example, in an embodiment in which the monitoring apparatus **710** may not be in immediate vicinity to provide the measured characteristic of the cable **701**, the storage unit **716** may be used to temporarily and/or permanently store the measured characteristic of the cable **701**. As such, in one or more embodiments, the storage unit **716** may include a non-volatile memory device to enable the measured characteristics and data collected by the monitoring apparatus **710** to be downloaded and received, with or without power to the monitoring apparatus **710**.

[0039] The output unit **718** of the monitoring apparatus **710** may be used to output the measured characteristic of the cable **701** from the monitoring apparatus **710**. The output unit **718** may enable data to be output and/or downloaded in real-time, pseudo real-time, and/or at a later time or date. The output unit **718** may therefore include a direct cable connection device to enable a cable to be input into the output unit **718** of the monitoring apparatus **710** to receive and/or download the measured characteristics and/or data collected by the monitoring apparatus **710**. Additionally or alternatively, the output unit **718** may include a wireless communication device, in which the wireless communication device may include an inductive coupling unit, a radio-frequency unit, a radio-frequency identification unit, and/or a near-field communication unit (e.g., Bluetooth technology).

[0040] As the monitoring apparatus **710** may be used to store data and/or the measured characteristics to be downloaded and received at a later time, the monitoring apparatus **710** may include a timing unit **720**. The timing unit **720** may enable the monitoring apparatus **710** to schedule monitoring activities of the cable **701**. Further, the timing unit **720** may be used to include a time stamp with the measured characteristics and/or data of the cable **701**. The time stamp may then be used to identify when the measured characteristics and/or data of the cable **701** were measured or gathered. Further, in one or more embodiments, the monitoring apparatus **710** may include an identification unit **722**, such as to include a unique identifier with the measured characteristics and/or data. In an embodiment in which a system includes multiple cables and multiple monitoring apparatuses, the identification unit **722** may include a unique identifier with the measured characteristics and/or data to determine which monitoring apparatus collected the data, and in turn, which cable is being monitored by the monitoring apparatus. Further, in one or more embodiments, the unique identifier of the identification unit **722** may be configurable, in that the unique identifier may be selectively changed as desired by a user.

[0041] As the output unit **718** of the monitoring apparatus **710** may include a wireless communication device, the system **700** may include a corresponding wireless device **730** to communicate with the wireless communication device of the monitoring apparatus **710** and receive the measured characteristic of the cable. For example, the wireless device **730** may include a wireless handheld device that may be moved into the vicinity of the monitoring apparatus **710** to receive the data from the monitoring apparatus **710**. This may involve using a wireless device **730** subsea, such as with a remote-operated vehicle (ROV) and/or an autonomous underwater vehicle (AUV), to receive and download data from the monitoring apparatus **710**. Additionally or alternatively, when the system **700** is pulled to the surface (such as when servicing the system **700** and/or any other components used in conjunction with the system **700**) the wireless device **730** may be used to receive and download data from the monitoring apparatus **710**.

[0042] In an embodiment in which the wireless communication device of the monitoring apparatus **710** includes passive technology, such as a radio-frequency identification unit, the wireless device **730** may be used to activate and/or stimulate the wireless communication device of the monitoring apparatus **710** to receive and/or download data from the monitoring apparatus **710**. Further, as the monitoring apparatus **710** may include an identification unit **722**, the wireless device **730** may be used to download and receive data from multiple monitoring apparatuses, each of the data sets including a unique identifier to identify the monitoring apparatus and the cable being monitored.

[0043] Referring still to FIG. 7, the monitoring apparatus **710** may include a power supply unit **724** to provide power, at least partially, for the monitoring apparatus **710**. In one embodiment, the power supply unit **724** may be used to receive power, at least partially, from the cable **701**, such as to receive power from a power conductor of the cable **701**. Additionally or alternatively, the power supply unit **724** may include one or more power sources, such as a battery (e.g., rechargeable battery). Power from other sources may also be provided to the power supply unit **724** to power the monitoring apparatus **710**, such as using techniques that may include direct connection and/or inductive coupling.

[0044] As discussed above, the monitoring apparatus **710** may be used to monitor a condition of the cable **701**, in which the cable **701** may be a pressure balanced oil-filled cable. In such an embodiment, the monitoring apparatus **710** may include one or more appropriate connectors to connect, such as directly connect, with the pressure balanced oil-filled cable. In particular, the monitoring apparatus **710** may include one or more API 16D connectors. Further, as the monitoring apparatus **710** may be used to monitor the condition of other cables, the monitoring apparatus **710** may include one or more replaceable connectors to enable the monitoring apparatus **710** to connect with different cables. As the monitoring apparatus **710** may directly connect to a cable, the connectors of the monitoring apparatus **710** may include the appropriate (e.g., same) amount and size of pins and/or sockets as that of the corresponding cable.

[0045] Further, in an embodiment in which a measurement of the cable **701** requires a loop to be formed with respect to the cable **701**, more than one monitoring apparatus **710** may be used to monitor the condition of the cable **701**. For example, as shown in FIG. **8**, a first monitoring apparatus **710**A may be connected to one end of the cable **701**, and a second monitoring apparatus **710**B may be connected to another end of the cable **701**. The first monitoring apparatus **710**A and the second monitoring apparatus **710**B may then be able to communicate with each other, such as through the cable **701**, through another cable, and/or wirelessly with each other. As such, in one embodiment, the first monitoring apparatus **710**A may be able to send signals through the cable **701** to the second monitoring apparatus **710**B to monitor the condition of the cable **701**. If necessary, the second monitoring apparatus **710**B may then send the same signal or a corresponding signal back to the first monitoring apparatus **710**A to measure a characteristic and monitor the condition of the cable **701**. In an embodiment in which more than one monitoring apparatus **710** is used to monitor the condition of the cable **701**, then more than one adapter **712** may also be used to connect the electronic components **703**A and **703**B, as shown.

[0046] The present disclosure, while discussed in relation to the use and monitoring of a condition of a cable, such as a pressure balanced oil-filled cable, is not so limited. For example, an apparatus and/or system in accordance with the present disclosure may be used with other types of cables and/or components, whether subsea and/or on the surface. For example, an apparatus in accordance with the present disclosure may be able to monitor the condition of a cable (e.g., non-pressure balanced oil-filled cable) that may be used within processing, production, and/or surface equipment. Accordingly, the present disclosure is not limited to only the above figures and descriptions shown above.

[0047] While the aspects of the present disclosure may be susceptible to various modifications and alternative forms, specific embodiments have been shown by way of example in the drawings and have been described in detail herein. But it should be understood that the invention is not intended to be limited to the particular forms disclosed. Rather, the invention is to cover all modifications, equivalents, and alternatives falling within the spirit and scope of the invention as defined by the following appended claims.

1. A system to monitor a condition of a cable, the system comprising:
- a monitoring apparatus connectable in-line with the cable, the monitoring apparatus comprising:
  - a measuring unit to measure a characteristic of the cable; and
  - a storage unit to store data related to the measured characteristic of the cable.

2. The system of claim **1**, the monitoring apparatus further comprising a determining unit to determine a condition of the cable based upon a comparison of the measured characteristic with a predetermined value for the characteristic.

3. The system of claim **1**, wherein the characteristic of the cable measured by the measuring unit comprises at least one of impedance, resistance, capacitance, inductance, propagation speed, propagation delay, and delay skew.

4. The system of claim **1**, wherein the monitoring apparatus is configured to monitor a condition of the cable related to at least one of degradation of insulation resistance of the cable, fluid ingress into the cable, and external impacts to the cable.

5. The system of claim **1**, wherein the monitoring apparatus is configured to monitor a condition of a data conductor and a power conductor of the cable.

6. The system of claim **5**, wherein the monitoring apparatus further comprises a power supply unit to power the monitoring apparatus, wherein the power supply unit is configured to receive power from at least one of the power conductor of the cable and an external source.

7. The system of claim **1**, wherein the monitoring apparatus further comprises a timing unit configured to include a time stamp with the measured characteristic of the cable, and wherein the measuring unit of the monitoring apparatus comprises a unique identifier to identify the cable.

8. The system of claim **1**, wherein the measuring unit of the monitoring apparatus measures the characteristic of the cable based upon at least one of a signal sent into the cable and a signal received from the cable.

9. The system of claim **1**, wherein the storage unit comprises an electronic memory storage unit comprising a non-volatile memory device.

10. The system of claim **1**, the monitoring apparatus further comprising an output unit to output the measured characteristic of the cable from the monitoring apparatus, wherein the output unit of the monitoring apparatus comprises a wireless communication device.

11. The system of claim **10**, wherein the wireless communication device comprises at least one of an inductive coupling unit, a radio-frequency identification unit, and a near-field communication unit.

12. The system of claim **10**, further comprising a wireless device to communicate with the wireless communication device of the monitoring apparatus and receive the measured characteristic of the cable.

13. The system of claim **1**, wherein the cable comprises a pressure balanced oil-filled cable, and wherein the monitoring apparatus comprises an API **16**D connector to connect with the pressure balanced oil-filled cable.

14. The system of claim **1**, wherein the monitoring apparatus is connected in-line with the cable between a first subsea component and a second subsea component.

15. The system of claim **14**, further comprising more than one monitoring apparatus with a monitoring apparatus connected to each end of the cable and configured to communicate with each other through the cable.

16. A monitoring apparatus connectable with a cable to monitor a condition of the cable, the monitoring apparatus comprising:
- a measuring unit to measure a characteristic of the cable;
- a determining unit to determine a condition of the cable based upon a comparison of the measured characteristic with a predetermined value for the characteristic;

a storage unit to store data related to the measured characteristic of the cable; and

an output unit to output the data related to the measured characteristic of the cable from the monitoring apparatus.

17. The monitoring apparatus of claim **16**, further comprising:

a power supply unit to power the monitoring apparatus, wherein the power supply unit is configured to receive power from at least one of a power conductor of the cable and an external source;

a timing unit configured to at least one of schedule when to measure the characteristic of the cable and include a time stamp with the measured characteristic of the cable; and

an identification unit to identify the cable.

18. The monitoring apparatus of claim **16**, wherein the storage unit comprises an electronic memory storage unit comprising a non-volatile memory device.

19. The monitoring apparatus of claim **16**, wherein the output unit of the monitoring apparatus comprises a wireless communication device.

20. The monitoring apparatus of claim **19**, wherein a wireless device is configured to communicate with the wireless communication device of the monitoring apparatus and receive the measured characteristic of the cable.

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