



- (51) International Patent Classification: Not classified
- (21) International Application Number: PCT/GB2013/052835
- (22) International Filing Date: 30 October 2013 (30.10.2013)
- (25) Filing Language: English
- (26) Publication Language: English
- (30) Priority Data: 1219493.2 30 October 2012 (30.10.2012) GB
- (71) Applicant: WFS TECHNOLOGIES LTD [GB/GB]; 16 Charlotte Square, Edinburgh, Lothian EH2 4DF (GB).
- (72) Inventors: HYLAND, Brendan Peter; 5 Comiston Rise, Edinburgh Lothian EH10 6HQ (GB). MACLEAN, Grant; 12 Gelder Drive, Livingston West Lothian EH54 9HX (GB).
- (81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM,

DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

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

Published:

— without international search report and to be republished upon receipt of that report (Rule 48.2(g))

- (54) Title: IMPROVED SUBSEA INSTALLATION DEPLOYMENT

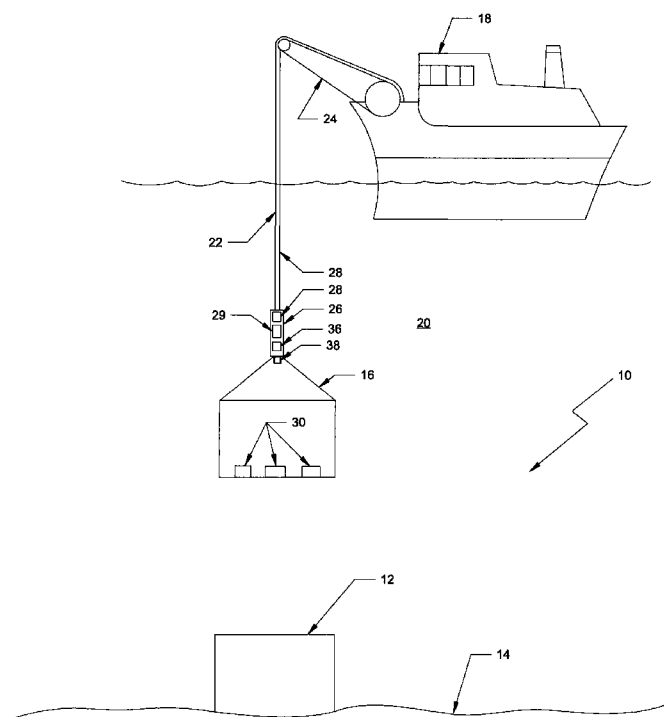


Figure 1.

(57) Abstract: A subsea deployment system comprising a deployment surface, the deployment surface being at a pre-determined position; a subsea installation component, the subsea installation component being deployed from above water to land relative to the deployment surface, and a deployment mechanism, the deployment mechanism being detachably engaged with the subsea installation component during deployment, the subsea installation component and the deployment system each having a wireless transceiver for transmission of signals between the subsea installation component and the deployment mechanism and wherein upon the subsea installation component landing relative to the deployment surface, data is transmitted between the transceivers such that the deployment system is actuated to detach from the subsea installation component.

IMPROVED SUBSEA INSTALLATION DEPLOYMENT

The present invention relates to monitoring of subsea installations and in particular, though not exclusively, to a subsea deployment system based on a wireless
5 monitoring system for use in the controlled deployment of a portion of a subsea installation onto a fixed subsea structure.

As energy requirements increase, technology is being developed to find and exploit new energy sources in our oceans. Offshore wind farms are being constructed and
10 tidal power generators are seeing a resurgence in interest. Oil and gas exploration and production is also venturing further into deeper waters. As a result large numbers of subsea installations are being constructed. In many instances control modules are located upon the installations together with process sensors, to control and operate the facilities once constructed. Large umbilicals connect the sensors
15 and control systems to the surface while delivering power to the installation.

Many subsea installations are constructed in sections, due to the weight and manoeuvrability of the sections. Additionally, further sections may be required at different instances in the lifetime of the installation for example, in workovers where
20 the installation is a subsea oil or gas well. During such deployment, communication by umbilical is only available to the new section being 'landed' upon the fixed construction. Typically cameras are used to relay images of the fixed structure to assist in 'docking' the new section upon the fixed structure. Stabbed connections are then used to provide communication through the entire subsea structure when
25 deployment is complete.

There are many disadvantages in using a camera based system. Deployment of the new section must be slow to ensure that the image is detected and analysed before the new section meets the fixed structure. Optical images are difficult to see and
30 interpret through sea water. This severely limits the range at which optical guidance can be used. In deep water, environmental indications of pressure and temperature can only be acquired from sensors mounted on the new section. Similarly gyros, inclinometers and accelerometers only provide measurements on the new section,

so that any movement of the fixed structure is unknown and cannot be compensated for.

WO2011/114152 to the present Applicant's describes a wireless auxiliary system for monitoring and control of an underwater installation. Data and control signals are sent between a lower stack in a hydrocarbon drilling or production facility and an associated riser assembly. Data is collected by locally powered sensors on the fixed lower stack and transmitted via an umbilical to surface. Additionally, the data is sent from a first transceiver located on the stack to a second transceiver located on the riser assembly by electromagnetic signals. This allows wireless transfer to occur between the lower stack and the riser assembly after the riser assembly is detached or just prior to reattachment. Such detachment and reattachment is required during periods of bad weather when the riser assembly can move significantly due to its attachment to a topside floating rig or vessel. This arrangement provides an advantage in that for a state of operation where the riser is disconnected, the ability to compare the last known state of the lower stack and the state immediately prior to reconnection provides information regarding any state change that might have been implemented in the period during which the riser was disconnected, e.g. through local intervention by a remotely operated underwater vehicle.

20

WO2011/114152 provides for the transmission of sensor data during detachment and reattachment of a riser assembly to a lower stack on an operating subsea well. It does not assist in the speed or guidance of the detachment or reattachment. Yet further it is limited to transferring data only during detachment and reattachment.

25

However, during actual deployment and release of the riser assembly, damage can be sustained if released too early, released too late or if the connection between the winch and the riser is subjected to a force or movement which causes damage to the connective link therefore damaging the riser unit and data communications link.

30

It is an object of the present invention to provide a subsea deployment system based on a wireless monitoring system for the controlled deployment of a portion of a subsea installation onto a predetermined surface.

According to a first aspect of the present invention there is provided a subsea deployment system comprising a deployment surface, the deployment surface being at a predetermined position; a subsea installation component, the subsea installation component being deployed from above water to land relative to the deployment surface, and a deployment mechanism, the deployment mechanism being detachably engaged with the subsea installation component during deployment, the subsea installation component and the deployment system each having a wireless transceiver for transmission of signals between the subsea installation component and the deployment mechanism and wherein upon the subsea installation component landing relative to the deployment surface, data is transmitted between the transceivers such that the deployment system is actuated to detach from the subsea installation component.

In this way, subsea deployment can be managed quickly acting upon real time information. Furthermore, upon the subsea installation component being located appropriately relative to the deployment surface, the deployment system can be automatically and swiftly detached from the subsea installation component preventing accidental subsequent movement of the subsea installation component and minimising potential for damage between the deployment system and the subsea installation and between the subsea installation and the deployment surface. Furthermore, as the data is communicated wirelessly between the deployment system and the subsea installation component no attendant communication cables require to be disconnected therefore the time taken during the detachment process is significantly minimised therefore reducing resources and time taken in deploying the subsea installation component.

Preferably, the deployment system comprises a cable, winch assembly and a slip ring assembly.

The deployment mechanism transceiver may be located in the slip ring assembly.

By incorporating the transceiver within the slip ring assembly, communication cables providing data to and from the receiver may similarly carry data to or from the transceiver.

Preferably, the data is transmitted as an electromagnetic and/or magneto-inductive signal. Signals based on electrical and electromagnetic fields are rapidly attenuated in water due to its partially electrically conductive nature. Propagating radio or electromagnetic waves are a result of an interaction between the electric and magnetic fields. The high conductivity of seawater attenuates the electric field. Water has a magnetic permeability close to that of free space so that a purely magnetic field is relatively unaffected by this medium. However, for propagating electromagnetic waves the energy is continually cycling between magnetic and electric field and this results in attenuation of propagating waves due to conduction losses. The seawater provides attenuation losses in a workable bandwidth which provides for data transmission over practical distances.

The data may be compressed prior to transmission. Compression allows the occupied transmission bandwidth to be reduced. In this way, increased data rates can be transmitted over equivalent distances.

Optionally, the data is compressed in combination with use of a lower carrier frequency. The lower carrier frequency leads to lower attenuation. This in turn allows data transfer through fluids over greater transmission distances. In this way the data compression and carrier frequency can be adjusted as the parts are brought together so that increased data is transmitted at closer distances.

Preferably, the data transmission is bi-directional. In this way, command and control signals can be transferred between the deployment system and the subsea installation component. Advantageously, at least the subsea installation component includes a local battery. In this way, transceiver(s), sensors and detectors, on the subsea installation component do not require an umbilical connection to surface.

Preferably, each transceiver has an electrically insulated magnetic coupled antenna. Alternatively, each transceiver has an electric field coupled antenna.

Because of the behavioural properties of electromagnetic signals and magneto-inductive signals in fluids, systems using magnetic couple antennas are more efficient and can operate over greater distances underwater than electrically coupled

antennas. However, in some circumstances an electric field coupled antenna may be advantageous. Electrically insulating the antenna provides further advantages. This is because for a non-insulated electrically coupled antenna, there is a direct conduction path between it and the dissipative water. This leads to dissipation as the signal propagates along the antenna even before the electromagnetic signal is launched. Providing an insulated antenna reduces this effect.

The antenna may be a wire loop, coil or similar arrangement. Such antenna create both magnetic and electromagnetic fields. The magnetic or magneto-inductive field is generally considered to comprise two components of different magnitude that, along with other factors, attenuate with distance (r), at rates proportional to $1/r^2$ and $1/r^3$ respectively. Together they are often termed the near field components. The electromagnetic field has a still different magnitude and, along with other factors, attenuates with distance at a rate proportional to $1/r$. It is often termed the far field or propagating component. Such a transceiver is manufactured by the Applicant, WFS Technologies.

The subsea installation may be one of a group comprising: a rig, a blow-out preventor, a lower stack, a wellhead, a Christmas tree, a drilling unit, a wind power generator support, a wave power generator, a separator, a pump, a manifold and a compressor.

Preferably, the transceivers provide positioning and guidance data as is known in the art. Preferably, the transceiver(s) on the subsea installation component are operable to collect data from sensors and/or detectors located on the subsea installation component. The sensors and/or detectors are preferably those required for positioning and guidance. In particular, but not exclusively, the sensors may comprise pressure sensors, gyroscopes, inclinometers or accelerometers.

Embodiments of the present invention will now be described, by way of example only, with reference to the accompanying drawings of which:

Figure 1 is a schematic illustration of a subsea installation during deployment according to an embodiment of the present invention;

Figure 2 is a block diagram of a transceiver for use in a system of the present invention; and

- 5 Figure 3 is a block diagram of an antenna for use in the transmitter or receiver of the transceiver of Figure 2.

Reference is initially made to Figure 1 of the drawings which illustrates a subsea installation, generally indicated by reference numeral 10, comprising a deployment
10 surface 12 which is a surface of a subsea installation unit which is located at a predetermined position, in this case on a fixed location on the seabed 14 and a subsea installation component 16 being deployed from a surface vessel 18 according to an embodiment of the present invention.

15 In Figure 1, the subsea installation 10 is illustrated schematically, but it may be any structure such as a rig, a blow-out preventor, a lower stack, a wellhead, a Christmas tree, a drilling unit, a wind power generator support, a wave power generator, a separator, a pump, a manifold and a compressor. While the subsea installation component 16 is shown as being deployed from a surface vessel 18, for larger
20 structures a rig may be constructed. The subsea installation component 16 is secured to the cable 22 by a deployment mechanism 26 which comprises a winch assembly 28 and slip ring assembly 29. The deployment mechanism 26 is provided with a transceiver 36 which is operable to be in communication with a transceiver 38 provided in the subsea installation component 16. As known, the subsea installation
25 component 16 is lowered towards and guided towards deployment surface 12. Control of the subsea installation component 16 is arranged from the vessel 18 by making adjustments to the crane 24. AUV's may be deployed around the first part 12 to assist in the landing of the second part 16 on the first part 12.

30 Sensors 30 located on the subsea installation component 16 can operate during deployment via transceivers 36 and 38 providing wireless connection enabling data to be transmitted to the umbilical 28. These sensors 30 can be those required for providing positioning, guidance and deployment confirmation data such as pressure sensors, gyroscopes, inclinometers or accelerometers. The sensors 30 can also

include mechanisms to monitor environmental conditions such as temperature and/or physical conditions such as tension on the cable 22 and /or umbilical 28. When landed, the sensors 30 can provide suitable data, such as positioning, orientation and pressure to the transceiver 36 and thus deployment mechanism 26
5 can receive an indication that accurate and secure deployment has occurred.

For the present invention, a transceiver 36 is located on the deployment mechanism 26 and a further transceiver 38 is located on the subsea installation component 16. The transceiver 38 is connected to the sensors 30 on the subsea installation
10 component 16. The connection between transceiver 38 and sensors 30 may be any suitable connection including a wireless connection or a cabled connection. With local power made available on the subsea installation component 16, data can be wirelessly transferred via the transceivers 36,38 to the deployment mechanism 26 as well as up the umbilical 28 to the vessel to indicate that the deployment process is
15 completed and the deployment mechanism 26 can be activated to detach from the subsea deployment component 16. Sensors 30 are likely to be measurement devices and may be selected from gauges, valves, sampling devices, a device used in intelligent or smart well completion, temperature sensors, pressure sensors, flow-control devices, flow rate measurement devices, oil/water/gas ratio measurement
20 devices, scale detectors, actuators, locks, release mechanisms, equipment sensors (e.g., vibration sensors), sand detection sensors, water detection sensors, data recorders, viscosity sensors, density sensors, bubble point sensors, composition sensors, resistivity array devices and sensors, acoustic devices and sensors, other telemetry devices, near infrared sensors, gamma ray detectors, H₂S detectors, CO₂
25 detectors, downhole memory units, downhole controllers, and locators.

In an embodiment, the transceivers 36,38 transmit wirelessly by an electromagnetic and/or a magneto-inductive signal. Reference is now made to Figure 2 of the drawings which illustrates parts of each transceiver 36,38. In transceiver 36, the
30 sensor interface 56 receives data from the measurement systems in the sensors 32 which is forwarded to data processor 58. Data is then passed to signal processor 60 which generates a modulated signal which is modulated onto a carrier signal by modulator 62. Transmit amplifier 64 then generates the desired signal amplitude required by transmit transducer 66. In the transceiver 36, there is a control interface

68 which sends command signals to the data processor 58 which are transmitted via the umbilical 28 to the vessel 18 as well as to the deployment mechanism 26. These command signals can be used to determine that accurate deployment has occurred and action the automatic detachment of the subsea installation component 16 from the deployment mechanism 26 whilst subsequent provision of the data to the vessel 18 enables the progress of the process to be monitored, and on the occasion of an issue arriving, enable an over-ride process to be implemented.

The transceivers 36,38 also have a receive transducer 70 which receives a modulated signal which is amplified by receive amplifier 72. De-modulator 74 mixes the received signal to base band and detects symbol transitions. The signal is then passed to signal processor 76 which processes the received signal to extract data. Data is then passed to data processor 58 which in turn forwards the data to control interface 68. For the transceivers 36 there is also a memory 78 which can store data for onward transfer if the transceivers 36,38 are too far apart. The control interface 68 in transceiver 36 passes the data up the umbilical 28 to the vessel 18 for analysis.

Figure 3 shows an example of an antenna that can be used in the transmitter and receiver of Figure 2. This has a high permeability ferrite core 80. Wound round the core are multiple loops 82 of an insulated wire. The number of turns of the wire and length to diameter ratio of the core 80 can be selected depending on the application. However, for operation at 125 kHz, one thousand turns and a 10:1 length to diameter ratio is suitable. The antenna is connected to the relevant transmitter/receiver assembly parts described in Figure 2 and is included in a sealed housing 84. Within the housing the antenna may be surrounded by air or some other suitable insulator 86, for example, low conductivity medium such as distilled water that is impedance matched to the propagating medium 20. The antenna can also be used to magnetically couple energy between the transceivers 36,38. In this regard the housing acts as a magnetic flux guide and the multiple loops 82 with the ferrite core 80 provide a transformer when a pair of transceivers are brought together. In order for successful energy transfer the two transceivers must be arranged close together, there being an acceptable gap of only 1-2cm. Thus the range for power transfer is much smaller than the range for data communication. Coupling efficiency reduces as frequency increases because of leakage inductance effects. Eddy current losses

increase with frequency so also act to reduce the bandwidth available for data transmission. Data and power transmission can be separated in frequency to allow simultaneous operation of the two functions. Transfer efficiency is more critical for power transfer than for data communication applications so a higher frequency will usually be assigned to the data communication signals. While a transceiver 36,38 is described with a common antenna for transmit and receive, separate antennas may be used. Additionally, a separate transmitter coil arrangement can be provided solely for power transfer.

10 In use, the deployment surface 12 is typically a fixed structure located on the seabed 14 although it will be understood that it may be the seabed itself. The subsea installation component 16 is removably attached to deployment mechanism 26 and is a structure required to be landed upon the deployment surface 12. The structures may, for example, be a fixed structure of a BOP and stacks at an offshore well, with
15 the further structure being a drilling control unit being brought in for additional drilling work. Transceivers 36,38 are as described herein before and mounted to the deployment mechanism and the subsea installation component 16 respectively. The subsea installation component 16 is lowered off the vessel 18 by crane 24, as is known in the art. The subsea installation component 16 is secured to the crane
20 cable 22 by deployment mechanism 26 with one transceiver 36 located in the deployment mechanism 26 and another transceiver 38 located on the subsea installation component 16. When the subsea installation component 16 is aligned with and located on the deployment surface 12, the sensors 30 provide data indicating this and the data from the sensors 30 can be provided to transceiver 36
25 from where it is wirelessly transmitted to transceiver 38. This data will be compressed to reduce the transmission bandwidth and allow the data to be transmitted over a low carrier frequency. When the data transmitted by transceiver 38 provides information which indicates that the subsea installation component 16 is securely deployed on the deployment surface 12, the transceiver 36 can provide an
30 activation signal to the deployment mechanism 26 and the deployment mechanism 26 can be activated to detach from the subsea installation component 16. Feedback controls can be set-up to enable the signals transmitted to be provided to the vessel thus allowing a override function to be implemented in the detachment process should an issue arise.

The principle advantage of the present invention is that it provides a subsea deployment system able to provide data which can be transferred from a component being deployed to the deployment mechanism thus providing real time feedback and
5 functionality which enables a deployment mechanism to determine if successful deployment has occurred.

A further advantage of at least one embodiment of the present invention is that it provides a subsea deployment system in which data activates the detachment of the
10 deployment mechanism from the component being deployed. This allows for quicker deployment so that temporary installations can be more rapidly installed in a more cost effective manner and with less risk of damage occurring to components.

A yet further advantage of at least one embodiment of the present invention is that it
15 provides a subsea deployment system which does not require umbilical connection to be made with the component being deployed as this connection can be maintained wirelessly.

It will be appreciated by those skilled in the art that various modifications may be
20 made to the invention herein described without departing from the scope thereof.

CLAIMS

1. A subsea deployment system comprising:
 - a deployment surface, the deployment surface being at a predetermined position;
 - a subsea installation component, the subsea installation component being deployed from above water to land relative to the deployment surface, and
 - a deployment mechanism, the deployment mechanism being detachably engaged with the subsea installation component during deployment,
- the subsea installation component and the deployment system each having a wireless transceiver for transmission of signals between the subsea installation component and the deployment mechanism and wherein upon the subsea installation component landing relative to the deployment surface, data is transmitted between the transceivers such that the deployment system is actuated to detach from the subsea installation component.
2. A subsea deployment system as claimed in claim 1 which further comprises a cable, a winch assembly and a slip ring assembly.
3. A subsea deployment system as claimed in claim 2 wherein the deployment mechanism transceiver is located in the slip ring assembly.
4. A subsea deployment system as claimed in any preceding claim wherein the data is transmitted as an electromagnetic and/or magneto-inductive signal.
5. A subsea deployment system as claimed in claim 4 where the data is compressed prior to transmission.
6. A subsea deployment system as claimed in claim 5 wherein the data is compressed in combination with use of a lower carrier frequency.
7. A subsea deployment system as claim in any one of claims 4 to 6 wherein data transmission is bi-directional.

8. A subsea deployment system as claim in any preceding claim wherein at least the subsea installation component includes a local battery.
- 5 9. A subsea deployment system as claimed in any preceding claim wherein each transceiver has an electrically insulated magnetic coupled antenna.
10. A subsea deployment system as claim in any preceding claim wherein each transceiver has an electric field coupled antenna.
- 10 11. A subsea deployment system in claim in claim 9 or claim 10 wherein the antenna is a wire loop, coil or similar arrangement.
- 15 12. A subsea deployment system as claimed in any preceding claim wherein the subsea installation is one of a group comprising: a rig, a blow-out preventer, a lower stack, a wellhead, a Christmas tree, a drilling unit, a wind power generator support, a wave power generator, a separator, a pump, a manifold and a compressor.
- 20 13. A subsea deployment system as claimed in any preceding claim wherein the transceivers provide positioning and guidance data.
- 25 14. A subsea deployment system as claimed in any preceding claim wherein the at least one transceiver on the subsea installation component is operable to collected data from sensors and/or detectors located on the subsea installation component.
15. A subsea deployment system as claimed in claim 14 wherein sensors and/or detectors are those required for positioning and guidance.
- 30 16. A subsea deployment system as claimed in claim 14 or claim 15 wherein the sensors comprise at least one of pressure sensors, gyroscopes, inclinometers or accelerometers.

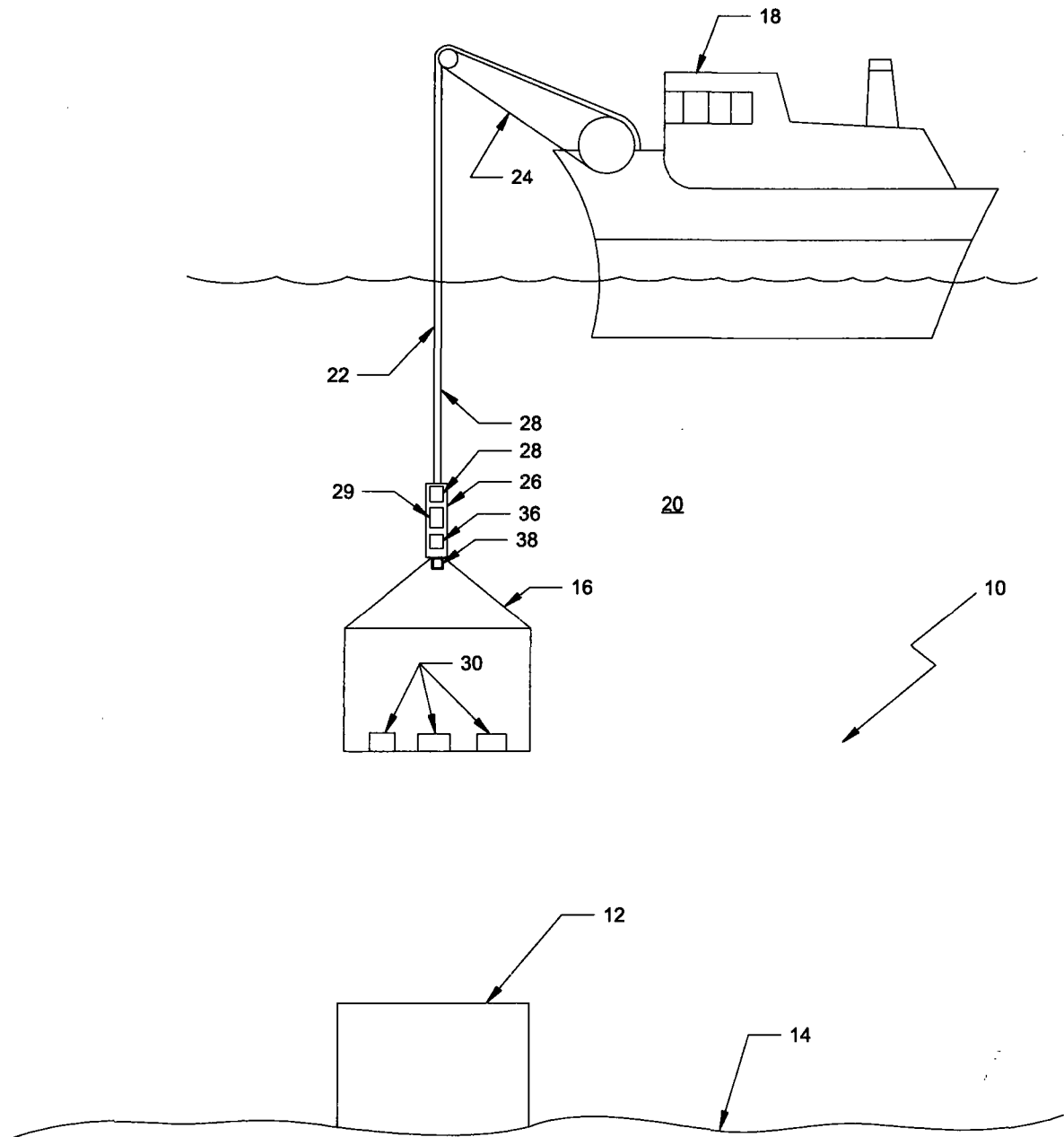
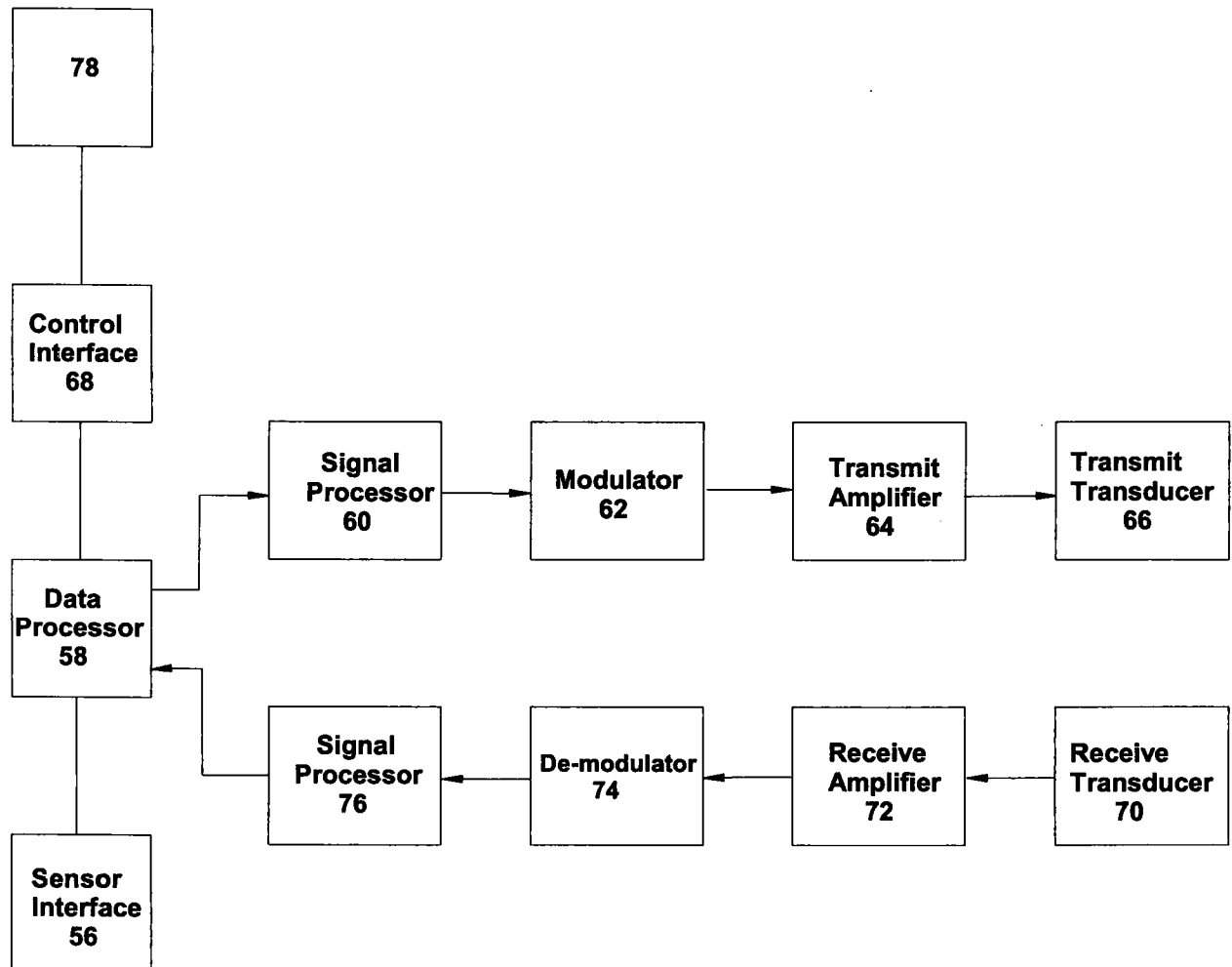


Figure 1.

**Figure 2.**

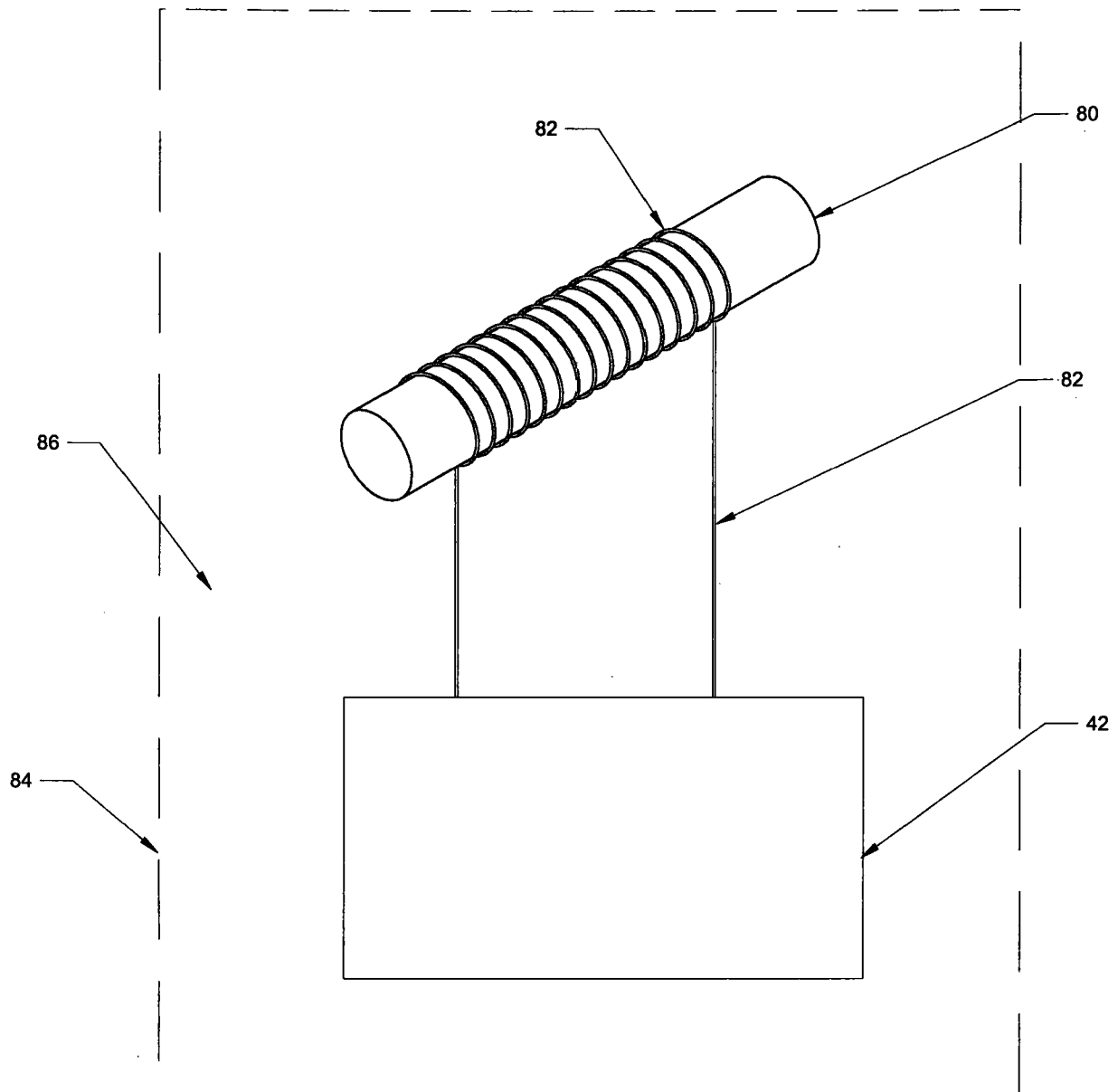


Figure 3.