July 15, 1969 B. S. BURRUS 3,455,114

SUBSEA SURFACE-COMMANDED EXTENSIBLE-RETRACTABLE APPARATUS

Filed March 21, 1968 2 Sheets-Sheet 1

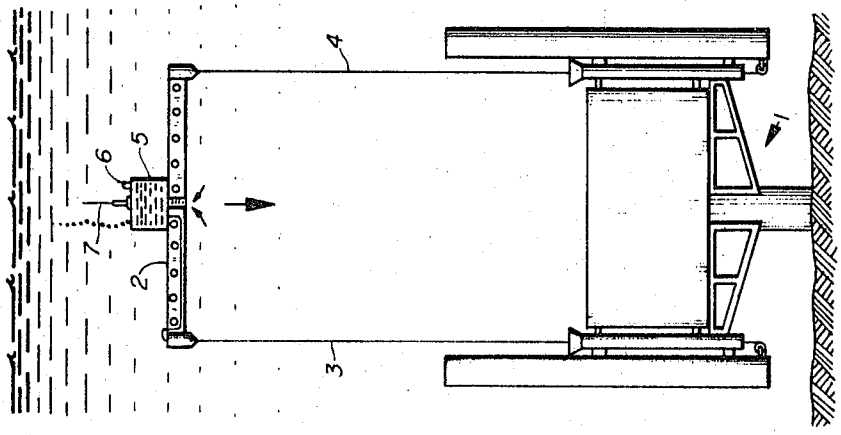


Fig. 3.

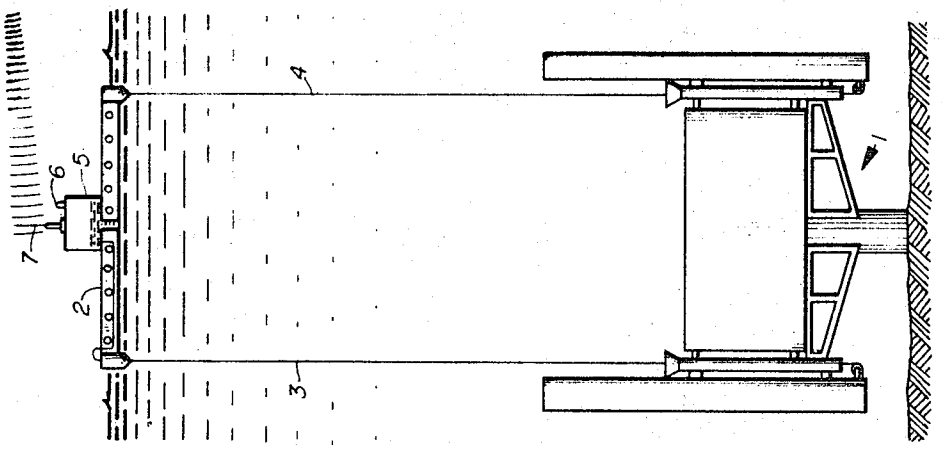


Fig. 2.

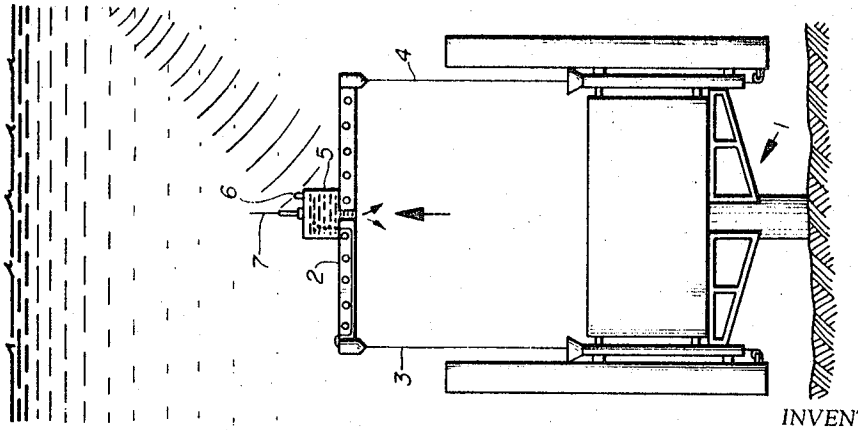


Fig. 1.

INVENTOR.
BILL S. BURRUS

BY Arthur L. Wade

ATTORNEY

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SUBSEA SURFACE-COMMANDED EXTENSIBLE-RETRACTABLE APPARATUS

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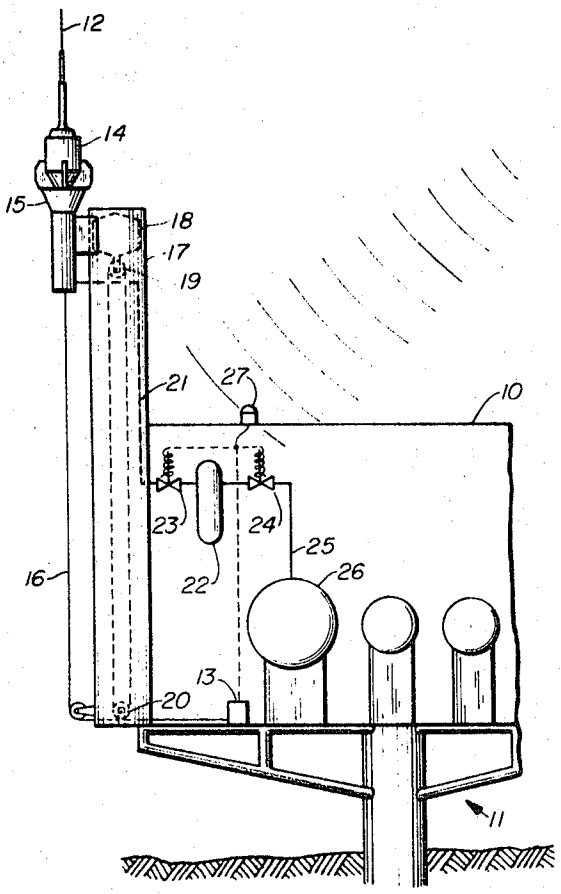


Fig. 4

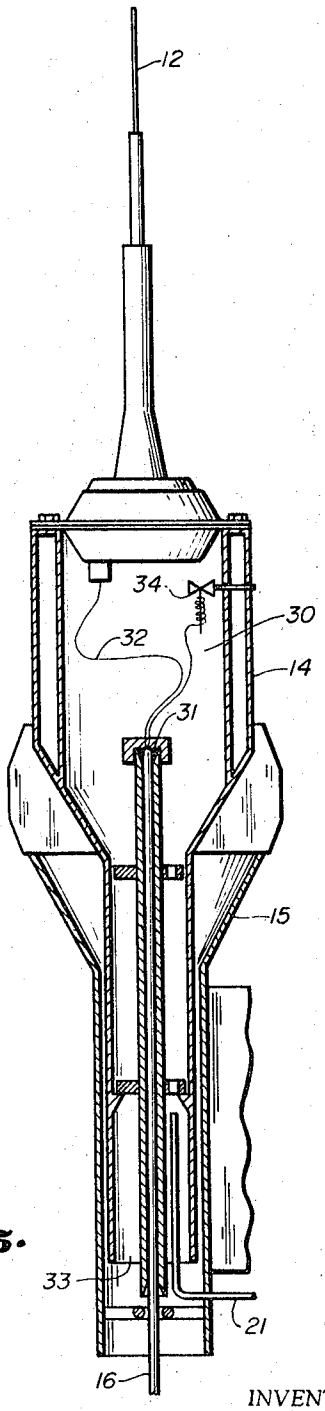


Fig. 5.

INVENTOR.
BILL S. BURRUS

BY Arthur L Wade

ATTORNEY

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3,455,114

SUBSEA SURFACE-COMMANDED EXTENSIBLE-RETRACTABLE APPARATUS

Bill S. Burrus, Tulsa, Okla., assignor to Combustion Engineering, Inc., New York, N.Y., a corporation of Delaware

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Int. Cl. E02b 17/00
U.S. Cl. 61—46 7 Claims

ABSTRACT OF THE DISCLOSURE

A subsea installation of equipment for producing an oil well has an extensible-retractable mechanism responsive to a command signal from the surface. A flotation system responds to the command signal by extending the subsea mechanism to the surface. The mechanism includes means for communicating between the surface and the subsea production equipment. Between communication periods, the flotation system is deactivated for retraction of the mechanism to its subsea location.

BACKGROUND OF THE INVENTION

Field of the invention

The present invention relates to actuation of subsea equipment from the surface. More particularly, the invention relates to utilizing a signal of relatively crude resolution to actuate a flotation system with which the subsea equipment is extended to the surface, thus allowing communication with surface locations by more precise and dependable communication means of an electrical or mechanical nature.

Description of the prior art

Oil field production devices are the first commercial equipment to be mounted at subsea installations and require sophisticated periodic adjustment. Some development has explored how to bring at least a portion of the equipment to the surface for adjustment. Additionally, there is a mad scramble to provide reliable communication equipment which will telemeter in situ conditions of the equipment and allow control of these conditions from the surface.

In general, the most desirable communication path is a direct wire connecting the subsea equipment to an onshore control station. The capital outlay for a cable installation and maintenance is usually prohibitive. Electromagnetic wave transmission through bodies of sea water is expensive, not precise, and difficult to render dependable. A compromise is found in extending a structure directly to the surface from the subsea location with a command signal from the surface. Electromagnetic wave transmission can then be established between the surface location and the subsea equipment. In addition, a measure of mechanical adjustment to the subsea equipment can be taken which includes the choice of floating the equipment to the surface for adjustment, repair, or replacement.

SUMMARY OF THE INVENTION

A principal object of the invention is to extend retractable equipment from a subsea installation by a command signal from the surface.

Another object is to employ flotation equipment to extend the retractable equipment to the surface.

Another object is to actuate flotation equipment, which will extend the retractable equipment to the surface, with a signal which will dependably travel through water from the surface.

Another object is to deactuate the flotation equipment to cause the extended equipment to automatically retract to its subsea location.

The present invention contemplates a flotation chamber tethered to a subsea installation with a float-pulley combination. The chamber is filled with gas when it is desired to overcome the retaining force of the float, and the chamber ascends to the surface with extensible apparatus required to communicate directly with the subsea installation.

It is further contemplated that gas for the chamber be released by equipment responsive to an acoustic signal sent through the water. The chamber can be vented of its gas at the surface for automatic retraction to the subsea installation by the float-pulley combination.

Other objects, advantages and features of this invention will become apparent to one skilled in the art upon consideration of the written specification, appended claims, and attached drawings, wherein;

FIGS. 1–3 are sectioned, schematic elevations of a subsea extensible-retractable structure in which the invention is embodied;

FIG. 4 is a sectioned, schematic elevation of a subsea extensible-retractable structure arranged to extend an antenna to the surface; and

FIG. 5 is a sectioned elevation of the buoy of FIG. 4 on which the antenna is mounted.

DESCRIPTION OF THE PREFERRED EMBODIMENT

The first group of drawings discloses the invention in the more elaborate embodiment. In general, an extensible-retractable structure is disclosed which is similar to that forming the subject matter of my co-pending application Ser. No. 671,365, filed Sept. 28, 1967. The extensible-retractable structure is mounted at a subsea location **1**. A prominent feature is the head structure **2** which is tethered by cables **3**, **4** above the subsea location. Chamber **5** is mounted on this head structure **2** and filled with sufficient liquid to limit the buoyancy of the head-chamber combination to retention in the retracted position of FIG. 1.

FIG. 2 depicts the results of the invention by which the FIG. 1 liquid in chamber **5** is displaced with gas. When the liquid is displaced, the chamber **5** adds enough buoyancy to the head-chamber combination to force the structure to the surface against the restrictive force of the pulley-float combination acting through cables **3**, **4**.

After the subsea structure has extended to the surface, it is retracted to the position depicted in FIG. 1. In FIG. 3, there is depicted the result of releasing gas from the chamber **5** until the entering liquid decreases the buoyancy to initiate retraction of the head-chamber combination. In FIG. 3, the retraction is taking place automatically, the structure returning to the position of FIG. 1.

The broad concept of extending and retracting structure between a subsea location and the surface is clearly embodied in the first three figures. Also included in the embodiment is the concept of mounting a receiver-controller at the subsea location for utilizing a signal from the surface through water. The receiver is indicated at **6**, mounted on chamber **5**. A control mechanism is connected to receiver **6** which is arranged to release gas from a source into the chamber **5** and displace the liquid therein. An acoustic signal may be satisfactory for this purpose.

An antenna **7** is shown, connected to the head-chamber combination. When the surface is reached, the antenna **7** is expected to receive electromagnetic signals for dependable communication between the equipment at the subsea location and a surface position. The foregoing arrange-

ment embodies the concept of using a relatively crude signal (possibly acoustic) from the surface to command the subsea equipment to extend to the surface where a more sophisticated form of signal may be employed to positively and reliably communicate between the surface position and the subsea location and control equipment located there.

It should now be apparent that mechanical communication with the subsea location is possible with this form of mechanism when it is extended to the surface. The mechanical communication may simply function to release equipment from the subsea mounting to permit subsequent raising of the equipment to the surface. However, it is also conceivable that some form of mechanical control could be exerted on portions of the equipment mounted at the subsea location. In all events, the extensible-retractable mechanism forms a bridge between the surface and whatever equipment is mounted at the subsea location. Over this bridge travels intelligence such as telemeter and control signals between the surface and equipment mounted at the subsea location.

FIGS. 1–3 do not disclose specific mechanism with which to make the mechanical communication. However, this disclosure is not necessary. The bridge for support of the communication structure is clearly shown.

Another detail not disclosed in connection with FIGS. 1–3 is the structure by which gas is communicated from a supply at the subsea location to chamber **5**. Cable **3** is depicted as extending to the chamber **5** for insertion of gas into chamber **5**. This cable **3** could be made up of a tubular element for the displacing gas. Additionally, electric conductors can be included in cable **3** for transmission signals from the antenna **7** and/or receiver **6**. In connection with FIGS. 1–3, it is not deemed necessary to disclose these details to get across the basic thrust of the novelty of the invention. With the structure shown, it is evident that a first, relatively crude signal through water, can command the subsea mechanism to extend to the surface. At the surface, the longer-range, more dependable electromagnetic waves can be the communication link with a surface position. Finally, the subsea mechanism can be commanded to retract to its normal position as depicted in FIG. 1.

The second group of drawings discloses the invention as applied to the problem of communicating only telemetry signals between a surface position not shown and subsea location shown in the drawings. An extensible-retractable structure embodies the invention. However, only the antenna of the communication system is reciprocated between the subsea location and the surface to establish the communication link between the surface position and the equipment at the subsea location. FIG. 4 depicts an assembly **10** of production equipment at the subsea location **11**. Antenna **12** is tethered into its retracted position at the subsea location. The structure in which the invention is embodied functions to extend antenna **12** to the surface and automatically retract the antenna **12** to the position shown.

Only a portion of the complete module of production equipment for an oil well is illustrated at **10**. This "package" of equipment is anchored to a platform. This module may be removed from the platform and guided to the surface for service, repair, or replacement. This problem does not concern the embodiment of the invention disclosed in FIG. 4.

In FIG. 4 the production equipment of assembly **10** may be adjustable to some extent by a control system actuated by signals received through antenna **12** when it is extended to the surface. Control unit **13** represents a system which is connected to antenna **12** and mounted with the units of assembly **10** to establish the communication and/or control desired as a final result.

Antenna **12** is mounted on a buoy **13** which is seated in a landing nipple **15** attached to assembly **10**. Antenna **12** has an electrical connection with unit **13** through electric conductor **16**. When antenna **12** is at the surface, electromagnetic waves are received by antenna **12** and transmitted through conductor **16** to unit **13**. The present problem is in extending antenna **12** to the surface and automatically retracting it to position shown in FIG. 4.

Cylinder **17** contains a float-pulley combination which normally keeps buoy **14** seated in landing nipple **15**. The buoyancy of float **18** generates an upward force which is great enough to keep buoy **14** in nipple **15** when buoy **14** contains a predetermined amount of liquid.

Pulleys **19**, **20** have multiple passes of the electric conductor **16** over them in order to provide for buoy **14** to extend to the surface within the range of vertical movement for float **18**. Buoy **14** will overcome the force of buoyancy of float **18** when a predetermined amount of gas is introduced to the interior of buoy **14** to displace a predetermined amount of liquid therefrom.

Displacing gas is introduced to the interior of buoy **14** through conduit **21**. A reservoir **22** of gas is mounted at a subsea location and connected to conduit **21** by a valve **23**.

After reservoir **22** has been depleted by passing gas through conduit **21**, valve **23** is closed and valve **24** opens. Valve **24** connects conduit **25** to reservoir **22**, passing gas from a source represented by tank **26** at the subsea location.

Valves **23**, **24** and receiver **13** are actuated as desired from a receiving device **27** mounted at the subsea location. The details of how **27** operates need not be disclosed. It is sufficient to disclose that receiver **27** is of the type which will receive a signal capable of travel through water from the surface position and energize **27** to bring about the desired control actions. A signal is initiated from the surface position which is received by **27**. Receiver **27** then opens valve **23** and gas flows from reservoir **22** into buoy **14** to displace enough water therefrom to cause buoy **14** to rise against the force of float **18** until the surface is reached. The subsequent release of a predetermined amount of this gas from buoy **14** will then enable float **18** to return buoy **14**, and attached antenna **12**, to the position shown in FIG. 4.

FIG. 5 is established to disclose the basic internal arrangement of buoy **14** as buoy **14** is carried in landing nipple. The interior of buoy **14** is designated **30**, and this interior **30** is occupied by either gas or liquid to operate over the cycle under the inventive concept.

Conductor **16** is shown as being attached to buoy **14** at **31**. Electric lead **32** completes the connection of wire **16** with antenna **12**. Conduit **21** extends up into the interior **30** to release gas from reservoir **22** when valve **23** is opened. As gas enters the space **30**, liquid is displaced therefrom and buoy **14** becomes sufficiently buoyant to rise to the surface. The displaced liquid passes from the bottom of buoy **14** through opening **33**.

Buoy **14** may take many forms. However, the concept of restraining the buoy **14** within landing nipple **15** by attachment to float **18** and subsequent extension to the surface when filled with gas from conduit **21**, is the common denominator of all contemplated forms for buoy **14**.

Once buoy **14** reaches the surface and communication is subsequently terminated, gas may be released from interior **30** in any number of ways to permit water to reenter buoy **14** and thereby enable float **18** to return buoy **14** to the position shown in FIG. 4. For example, FIG. 5 shows electrically operated vent valve **34** which would open and close upon command from a surface location.

From the foregoing it will be seen that this invention is one well adapted to attain all of the ends and objects hereinabove set forth, together with other advantages which are obvious and which are inherent to the apparatus.

It will be understood that certain features and subcombinations are of utility and may be employed without reference to other features and subcombinations. This is contemplated by and is within the scope of the claims.

As many possible embodiments may be made of the invention without departing from the scope thereof, it is to be understood that all matter herein set forth or shown in the accompanying drawings is to be interpreted as illustrative and not in a limiting sense.

The invention having been described, what is claimed is:

1. A subsea communication mechanism, including,
a chamber adapted to be filled with gas which will generate a force sufficient to elevate the chamber to the surface against a predetermined restraining force,
a float-pulley combination attached between the chamber and a subsea location to generate a predetermined restraining force on the chamber,
structure attached to the chamber with which communication between a surface location and the subsea location is established when the chamber reaches the surface,
a source of gas,
means connected between the gas source and the chamber with which gas from the source displaces liquid from the chamber to generate the force required to raise the chamber to the surface,
and means mounted at the subsea location and adapted to respond to a signal transmitted through the water thereby actuating the connection between the source of gas and the chamber.

2. The mechanism of claim 1, wherein,
the communication structure attached to the chamber includes an antenna adapted to receive and transmit electromagnetic energy between the surface and subsea locations.

3. The mechanism of claim 1, wherein,
the means connected between the gas source and the chamber includes a valve between the gas source and the chamber which is opened to discharge gas into the chamber.

4. An extensible-retractable subsea system for an antenna, including,
a buoy with a buoyancy dependent upon the relative amounts of liquid and gas within an internal compartment of the buoy,
an antenna mounted on the buoy so that it will be carried above the water level when the buoy floats on the surface above the subsea location,

an electric conductor connected to the antenna and the buoy and extending between the buoy and a subsea location,
a float and pulley system at the subsea location connected to the electric conductor so as to urge the buoy down to the subsea location with a predetermined force applied to the conductor,
a first receiver-controller at the subsea location and connected to the conductor to receive and transmit signals through the antenna when the buoy is at the surface,
a supply of gas at the subsea location,
a conduit connected to the supply to communicate the gas of the supply to the internal chamber of the buoy,
a valve in the gas supply conduit, and
a second receiver-controller connected to the valve to actuate the valve and communicate the gas of the supply to the buoy chamber when an appropriate signal is received by the second receiver-controller.

5. The system of claim 4, wherein,
the internal compartment has an opening in the lower portion of the buoy,
and the conduit for gas is arranged to extend upward through the opening to insert gas which will displace liquid from the chamber through the opening.

6. The system of claim 4, wherein,
the supply includes a chamber which is alternately valved to connect the chamber to a source of gas and the conduit with which the gas communicated to the internal chamber of the buoy.

7. The system of claim 4, including,
means for releasing gas from the internal chamber of the buoy so water will enter the chamber and reduce the buoyancy of the buoy.

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JACOB SHAPIRO, Primary Examiner

U.S. Cl. X.R.

61—69; 166—.6; 175—7; 340—8