United States Patent [19]

Brasier

[11] **3,866,160**

[45] **Feb. 11, 1975**

[54] **SIGNALING THE LOCATION OF UNDERWATER WELLS**

[76] Inventor: **Charles A. Brasier,** 4508 Wade Dr., Metairie, La. 70003

[22] Filed: **May 29, 1969**

[21] Appl. No.: **828,925**

[52] **U.S. Cl.** ..... **340/5 R,** 166/65 R, 166/153, 166/156, 166/253, 181/0.5 R, 181/0.5 A

[51] **Int. Cl.** **H04b 13/02,** E21b 47/12

[58] **Field of Search** ..... 166/65 R, 253, 66, 77, 166/153, 156; 181/0.5 A, 0.5 P, 0.5 R; 340/5 R, 15

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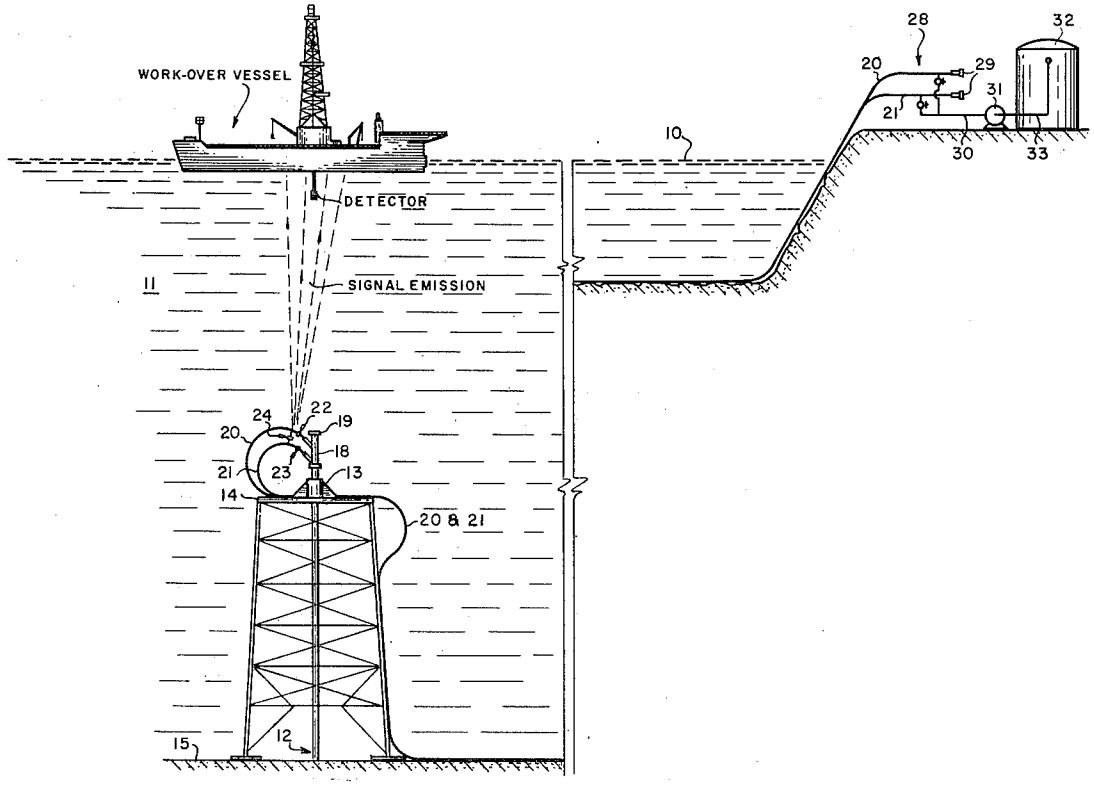
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Primary Examiner—Maynard R. Wilbur
Assistant Examiner—H. A. Birmiel
Attorney, Agent, or Firm—John S. Schneider

[57] **ABSTRACT**

Method and apparatus for use in locating the position of underwater wells involves a signal emitter adapted to be propelled through a flow line to a selected point proximate a wellhead where it signals the location of the well for such purposes as establishing the vertical re-entry point of the well for workover rigs.

4 Claims, 8 Drawing Figures



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SHEET 1 OF 2

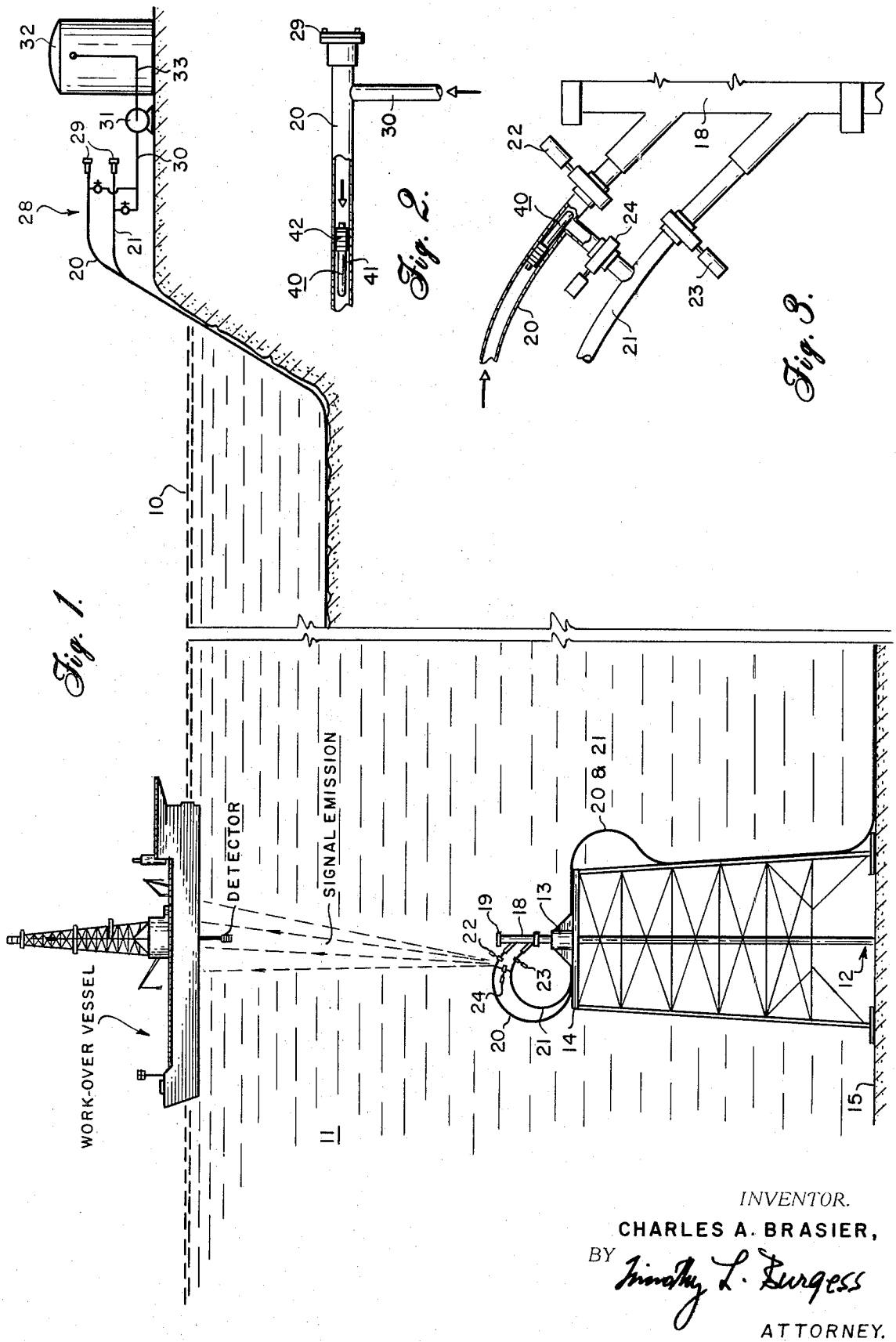


Fig. 1.

Fig. 2.

Fig. 3.

INVENTOR.

CHARLES A. BRASIER,

BY Timothy L. Burgess

ATTORNEY.

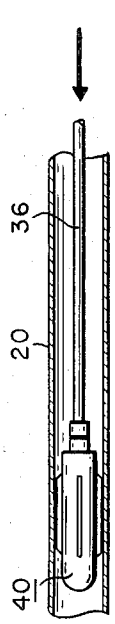


Fig. 5.

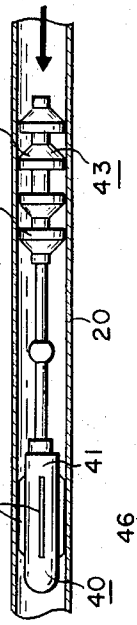


Fig. 6.

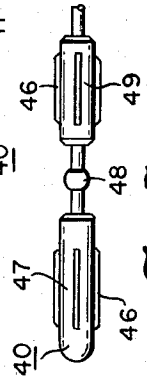


Fig. 7.

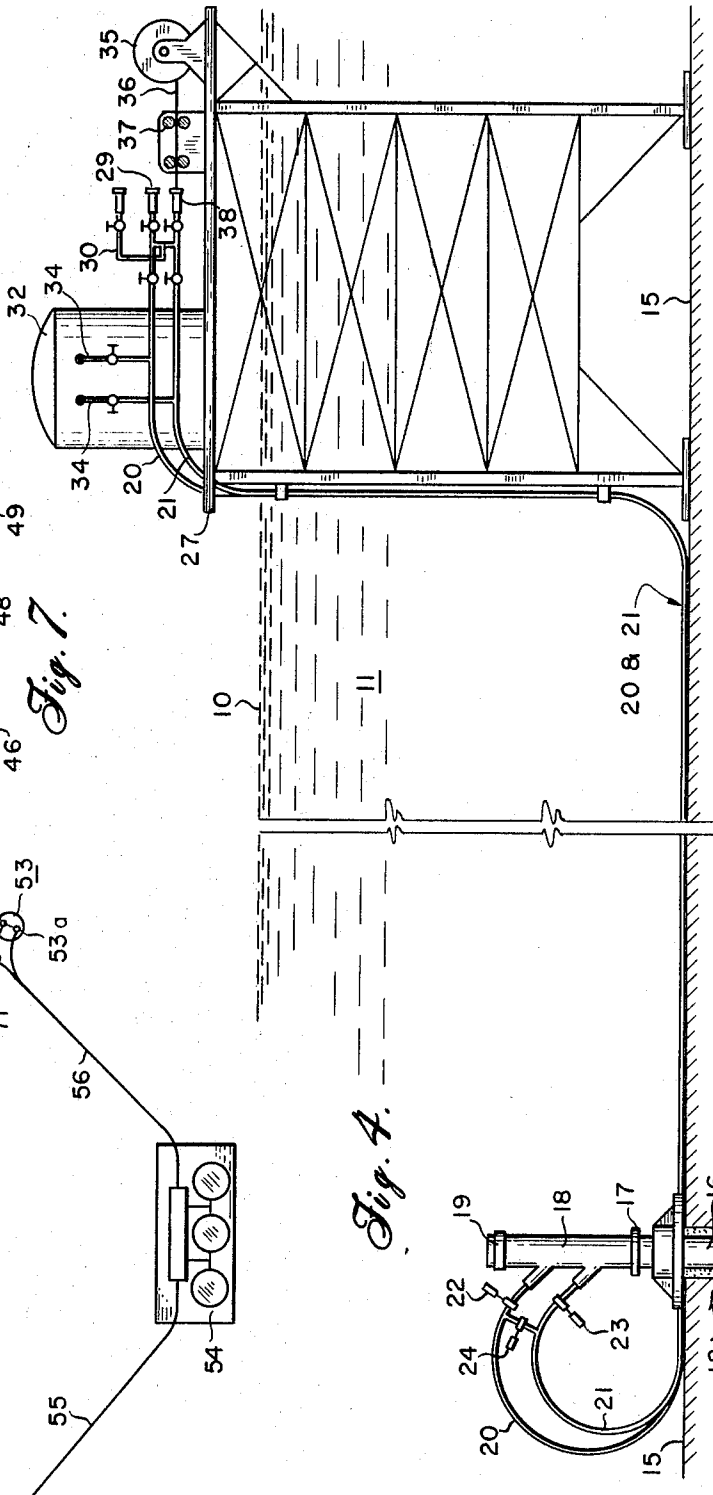


Fig. 4.

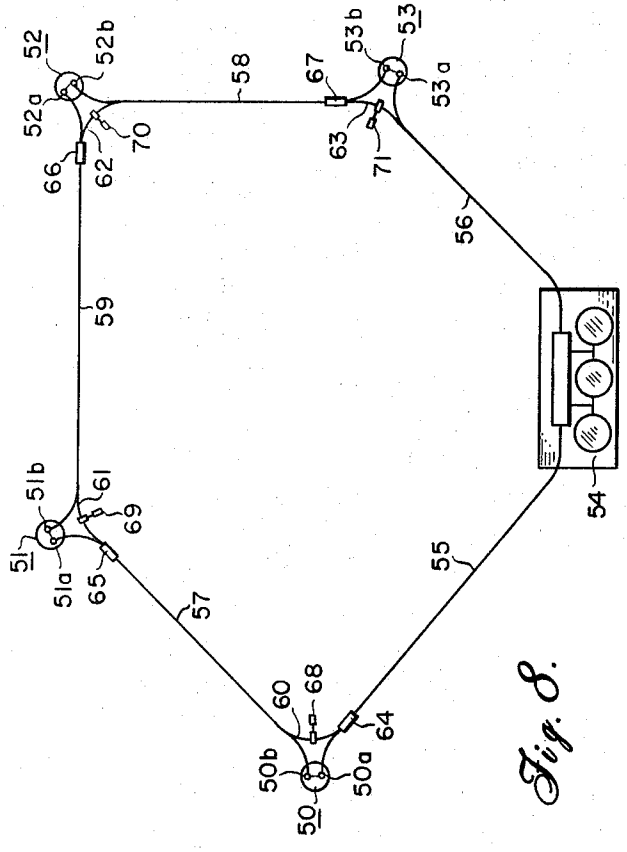


Fig. 8.

INVENTOR.
CHARLES A. BRASIER,
BY Timothy L. Burgess
ATTORNEY.

SIGNALING THE LOCATION OF UNDERWATER WELLS

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to the problem of locating underwater wells. More particularly, the invention is directed to locating an underwater well having a flow line extending into the well from an accessible but remote point. More specifically, the invention is concerned with method and apparatus for employing through flow line techniques to run tools, and the like, in wells, and is particularly adapted to the use of such techniques in underwater wells.

2. Description of the Prior Art

Devices (such as acoustical beacons) are known and used to mark and signal the location of underwater wells, so that, for example, vertical re-entry can be made through the wellhead into a well for workover operations. These signal devices, typically attached by divers at or near the well or wellhead, are continuously subjected to the rigors of the underwater environment, which accelerates the end of the useful life of their energy sources, usually batteries. This necessitates periodic replacement or maintenance of the signal device or its power source, a difficult operation that takes highly expensive manpower and seagoing equipment. As exploration for oil moves into deeper and deeper waters, to the extent that divers are still able to do these jobs, the costs will get even dearer, and known methods of locating the underwater wellhead to protect the investment it represents will be inadequate.

SUMMARY OF THE INVENTION

This invention overcomes the limitations and problems associated with the deployment, protection and recovery of known underwater signal devices by making use of equipment usually already on site with techniques now in the hands of producers of oil from subsea locations. It has as its purposes and objects the provision of apparatus and method that not only is useful for locating the position of an underwater well, but further, permits installation, retrieval and change of underwater signal devices without the use of divers or remote manipulators. In addition, it provides an underwater signaling device which is not subjected to the ocean environment. A special feature of the invention is that it enables one signal source to be used to serve several wells, thereby reducing the number of sources needed for that purpose.

Briefly, these and other objects of the invention are accomplished by a signal emitter adapted to be propelled to and from a selected point in a conduit forming a passageway extending from an accessible remote place into an underwater well having a wellhead. The selected point in the conduit is proximate the wellhead. In one aspect, the conduit is curved, and either fluid pressure or mechanical force originating externally of the conduit is exerted against the signal emitter to propel it through the conduit. When the signal emitter is adapted for fluid pressure propulsion, at least a portion of the signal emitter is shaped to close the annulus between it and the inner wall of the conduit sufficiently to permit it to be pumped through the conduit to the selected point in the conduit. By inserting a signal emitter adapted to be propelled through a conduit forming a passageway extending into an underwater well from an accessible remote place, and then by moving it through the conduit to a predetermined point in the conduit proximate the wellhead of that underwater well, one is enabled to signal the precise location of that well.

BRIEF DESCRIPTION OF THE DRAWINGS

Forms in which the invention may be embodied are shown in the drawings accompanying and forming part of the present specification. Referring to the drawings:

FIG. **1** is a schematic view of a well completed off water bottom showing curved conduit extending into a wellhead;

FIG. **2** is a side elevational view of a portion of conduit remote from an underwater wellhead, with a portion of the conduit broken away to reveal a signal emitter in passage;

FIG. **3** is a side elevational view of a portion of a Christmas tree at an underwater wellhead, with a portion of a conduit extending into the wellhead being broken away to show a signal emitter which has been run into place;

FIG. **4** is a schematic view of a well completed on water bottom in which curved conduit extends into a wellhead;

FIG. **5** is a view in vertical longitudinal section of a portion of conduit carrying a mechanically propelled signal emitter in transit;

FIG. **6** is the same view as FIG. **5**, but showing a signal emitter being moved by fluid pressure;

FIG. **7** is a side elevational view of a signal emitter of this invention; and

FIG. **8** is a schematic top plan view of a conduit system in which the present invention may be employed.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The forms shown in the drawings will now be described in detail for the purpose of illustrating how the general principles of the invention may be carried out.

Referring now to the drawings, in which identical numerals identify like parts in the various embodiments, and in particular to FIGS. **1** and **4**, reference numeral **10** indicates the surface of a body of water **11** in which an underwater well generally indicated by reference numeral **12** is completed. In FIG. **1**, underwater well **12** is completed at a wellhead **13** on a submerged platform **14** off water bottom **15**. In FIG. **4**, underwater well **12** is completed on water bottom **15**. A well casing **16** is arranged in the underwater well and cemented into place by the usual techniques. Attached to well casing **16** by flange members or connectors **17** is a wellhead Christmas tree **18** which is closed at its open end by flanged member or connector **19**. It will be noted that the well **12** is completed substantially below water surface **10**.

Connected to the Christmas tree **18** are a plurality of curved flow lines conduits **20** and **21**, whose passage into the Christmas tree is regulated by wing valves **22** and **23**. Flow lines **20** and **21**, which are interconnected above wing valves **22** and **23** by a bypass valve **24**, connect respectively to tubing or pipe strings **25, 26** which extend into the well to one or more hydrocarbon productive strata (not shown) from which oil and/or gas may be obtained or into which fluids may be injected. The tubing strings **25, 26** may suitably be intercon-

nected at one or more points intermediate their end for workover operations and the like. Flow lines **20** and **21** extend into well **12** from an accessible remote station, such as the support platform **27** which may be grounded on bottom **15** by suitable structure as illustrated in FIG. **4**, or an onshore site **28** as illustrated in FIG. **1**.

In FIG. **1**, flow lines **20** and **21** are terminally closed with suitable removable covers **29**. A line **30** provided with suitable valves connects a pump **31** into flow lines **20** and **21**. Pump **31** is connected to a source of fluid **32** by means of a line **33**. That fluid may suitably be oil produced from strata underlying water bottom **15**. Similarly, in FIG. **4**, lines **20** and **21** are adapted to be connected by valve controlled line **30** to a pump (not shown). Fluid can pass from a source **32** into lines **20** and **21** under control of valved lines **34**. Lines **20** and **21** have valves on both sides of the inlet from line **30**. In addition, platform **27** is provided with a pipe reel **35** onto which is wound a continuous length of substantially inflexible tubing **36** (tubing which will support its own weight). Tubing **36** feeds off pipe reel **35** across straightening rollers **37** (such as described by McStravick in U.S. Pat. No. 3,116,793 issued Jan. 7, 1964) through an adapter **38** into flow line **21**.

A signal emitter **40** adapted to be propelled through a flow line conduit, in accordance with this invention, is illustrated in FIG. **2**. A housing **41** encloses a sonic pinger or radioactive source or an electrical high frequency transmitter. Housing **41** is fitted with a piston **42** closing the annulus between the inner wall of flow line conduit and the housing sufficiently to permit the signal emitter to be pumped through the flow line by fluid pressure exerted against the piston. Another way in which signal emitter **40** is adapted to be pumped through a flow line is shown in FIG. **6**. The signal emitter **40** may be carried by a tool or locomotive assembly **43** constructed for movement in a flow line. In the form illustrated, the signal emitter housing **41** is secured to a locomotive assembly **43** comprised of a series assembly of two-way pump cups **44** and **45** closing the interior of flow line **20** sufficiently to permit locomotive assembly **43** to be pumped therethrough. The pistons employed on signal emitter **40** and locomotive assembly **43** may suitably be structured with ball valve passages as known to the art. The housing **41** of the signal emitter **40** may have nonclosure runners or slides **46** to decrease wobbling or prevent jamming of the emitter housing during passage. The piston **42** of the signal emitter **40** in FIG. **2** may incorporate the whole length of the housing to provide this protection. The fluid pressure exerted against signal emitter **40** or locomotive assembly **43** to pump the signal emitter through flow line **20** is supplied by the action of pump **31**.

In addition to the pumpdown methods of delivering a signal emitter through a conduit to a predetermined site, mechanical force originating externally of the conduit may be exerted on the signal emitter to accomplish the same result. As shown in FIGS. **4** and **5**, a signal emitter **40** is adapted to be propelled through flow line **20** by the feed of the continuous length of tubing **36** from pipe reel **35** across straightening rollers **44**.

Loops presently formed in two-inch flow lines have a typical diameter of about 5 feet, and the length of any cylindrical segment moved through such flow lines is limited to about 8 to 10 inches. Various levels of power may be needed to drive the circuitry of different signal emitters transmitting radio frequencies, yet space limitations may limit the size of the power source that can be contained in the same housing with the circuitry. However, as illustrated in FIG. **7**, the signal emitter may be made up of a segment **47**, containing the signal generating circuitry, electrically linked by a flexible coupling **48** to another segment **49**, containing one or more power sources. Segment **49** may be connected by a flexible coupling to another segment carrying a power source, and in this way, any desired level of power to drive the signal generating circuitry may be obtained.

The preselected point in the conduit to which the signal emitter is propelled is proximate the wellhead of well **12**. Most advantageously, where the wellhead is fitted with a Christmas tree, as illustrated in FIGS. **1** and **4**, the wing valves **22** and **23** may be closed, the bypass valve **24** opened, and the signal emitter of FIG. **3** or locomotive assembly and signal emitter of FIG. **4** pumped down to lodge at the site of the wing valve **22** in the flow line **20**. Generally, the task of locating the re-entry point of the well, which is the wellhead, is less advantageously served by placing the signal emitter below the wellhead. However, in some instances, such as when the wellhead is a substantial distance above water bottom (FIG. **1**), it may be desired to locate the signal source in the flowline at some distance intermediate the level of wellhead **13** and water bottom **15**, or in some instances, even adjacent water bottom **15**. This may be accomplished by propelling the signal emitter to the wellhead and then pumping the volume of fluid through the flow line which would displace a column of fluid whose height equals the distance down the flow line from the wellhead which it is desired to place the emitter. Alternatively, the tubing **36** driven by pipe reel **35** may be employed to propel the signal emitter down the flow line to a preselected site adjacent the wellhead or between it and the water bottom by measuring the length of tubing rolled off the reel into the flow line.

In the practice of the present invention, referring to the FIGS. **1–7** inclusive, the position of an underwater well **12**, and particularly wellhead **13**, is made ascertainable by inserting a signal emitter **40** adapted to be propelled through a flow line into such flow line, closing the flow lines with covers **29**, and propelling the signal emitter through the flow line to a selected point in the flow line conduit proximate the wellhead **13**, where it operates to signal the position of the well.

As illustrated in FIGS. **1** and **3**, signal emitter **40** has been pumped to Christmas tree **18** with wing valves **22** and **23** closed and the bypass valve **24** open. A sonic pinger, a radioactive source, or a high frequency transmitter in signal emitter **37** sends out signal which are picked up by an acoustical, radioactive or high frequency signal detector carried by a workover rig or the like riding on water surface **10**.

To retrieve the pumped down locomotive assembly and sonic emitter, the wing valves **22** and **23** are maintained closed and bypas valve **24** is kept open. Fluid is pumped down through the flow line **21** to reverse circulate flow between flow lines **21** and **20** and thereby pump signal emitter **40** through flow line **20** from the Christmas tree **18** on the wellhead **13** to support platform **27** or onshore site **28**, where the signal emitter may be removed from line **20**.

The emitter delivered to site by tubing **36** is retrieved by withdrawing the tubing to which the emitter is attached. Alternatively, if the tubing has already been

withdrawn, a "grabber" tool may be run down the flow line and attached to the emitter by pump or mechanical action and retrieved by pumping or by retrieval of tubing.

As illustrated in FIG. 8, the signal emitter of the present invention may be utilized to locate the positions of a selected one of a plurality of horizontally spaced underwater wells **50, 51, 52** and **53.** Each of the underwater wells has conventional wellheads (not shown) mounting therein at least two pipe strings (e.g., **50***a* and **50***b* in well **50**). These two pipe strings are interconnected at some point along their length, such as adjacent their lower ends. Each of the wells **50, 51, 52** and **53** is connected into a single flow line circuit that is normally underwater except at an accessible remote platform **54**, where the flow line circuit starts and ends.

The flow line circuit is made up of fluidly communicating conduits **55, 56, 57, 58, 59, 60, 61, 62** and **63,** which form fluid passageways. In the flow line circuit, flow line conduits **55** and **56** each extend from the remote platform **54,** where they are accessible, to connect, respectively, with an interconnecting pipe string in underwater wells **50** and **53,** e.g., pipe strings **50***a* and **53***a*. The other interconnecting pipe strings of wells **50, 53** and the interconnecting pipe strings of wells **51,** 52 are successively fluidly interconnected by underwater flow lines **57, 58** and **59.** Flow line **57** interconnects pipe string **50***b* (interconnected with pipe string **50***a*) with pipe string **51***a;* flow line **59** interconnects pipe string **51***b* (interconnected with pipe string **51***a*) with pipe string **52***a;* and flow line **58** interconnects pipe string **52***b* (interconnected with pipe string **52***a*) with pipe string **53***b*, interconnected with pipe string **53***a*. One or both of the pipe strings connected into the flow line circuit may be controlled by means of valves, in the manner disclosed in Ser. No. 604,670, filed Nov. 21, 1967 for Thomas W. Childers and Edmond R. Genois and having a common assignee with the present application.

Bypass flow line conduits **60, 61, 62** and **63,** respectively proximate each of the wells **50, 51, 52** and **53,** interconnect, respectively, flow line conduits **55** and **57,** 57 and **59, 59** and **58,** and **58** and **56.** Admission of fluid into any of bypass conduits **60, 61, 62** and **63** or into the pipe strings of wells **50, 51, 52** and **53** is controlled by a flow path diverter switch, constructed, for example, after the teachings of U.S. Pat. Nos. 398,836; 904,414; 3,206,140; and 3,410,501. The flow path diverter switch is placed proximate either or both entrances of the bypass conduit at all wells, for example, at one of the connection unions between a bypass conduit and one of the flow path conduits, as illustrated in FIG. 8, in which the flow path diverter switches are enumerated **64, 65, 66** and **67.** Placement of the diverter switch at the left entrance to the bypass conduit, as illustrated in FIG. 8, permits clockwise flow through the flow line circuit. Conversibly, placement of the diverter switch at the right entrance to the bypass conduit allows counter-clockwise flow. Diverter switch installation at both entrances of the bypass conduit enables the operator to use both clockwise and counter-clockwise flow. Each of the bypass flow lines **60, 61, 62** and **63** is provided with a suitable foraminous stop **68, 69, 70** and **71,** respectively, mounted therein to control (permit or prevent) passage of through flow line tools through the bypass flow line while permitting fluid passage, therethrough. Compare, for example, the foraminous vane of U.S. Pat. No. 3,261,048.

To establish a flow path to a position proximate a selected well, all the flow path diverter switches between the remote accessible platform **54** and the flow path diverter switch of the well immediately past the selected well are actuated to establish a mandatory flow path into the bypass conduits from the platform **54** up to and inclusive of the bypass conduit of the selected well. All the bypass conduit stops between the diverter valve of the selected well and the remote platform **54** are opened and the stop for the bypass conduit of the selected well is closed. For example, in FIG. 8, flow path diverter switches **64, 65** and **66** are operated to divert flow into bypass conduits **60, 61** and **62,** and bypass conduit stops **68** and **69** are opened while stop **70** is closed. Thus, a tool attaching or incorporating a signal emitter may be inserted into remotely accessible conduit **55** and propelled by fluid pressure exerted on it, successively through conduits **55, 60, 57, 61** and **59** into conduit **62,** where it is lodged. By this manner, the position of a selected underwater well among a plurality of underwater wells may be ascertained. Retrieval of the signal emitter may be effected by opening stop **70,** switching diverter valve **67** into bypass conduit **63,** and opening bypass conduit stop **71** to open a circuit for the emitter back to platform **54.**

The nature and objects of the present invention, having been fully described and illustrated, what id claimed is:

I claim:

1. A method of locating the position of a selected underwater well among a plurality of horizontally spaced-apart wells, each having an underwater wellhead and at least two interconnected pipe strings, each of said wellheads being interconnected successively to another of said wellheads by underwater conduits forming fluid passageways providing fluid communication from one well to another, at least two of said wells having a remotely accessible conduit fluidly communicating with a remotely accessible location, said remotely accessible conduits forming with said underwater conduits a flow line circuit beginning and ending at said remote accessible place, said method comprising:

a. inserting a signal emitter into one of said remotely accessible conduits; and

b. propelling said signal emitter through said flow line circuit to a selected position in said flow line circuit proximate said selected underwater well.

2. An apparatus for signaling the location of a selected underwater well among a plurality of horizontally spaced-apart underwater wells, each having an underwater wellhead and at least two interconnected pipe strings, each of said wellheads being interconnected successively to another of said wellheads by underwater conduits forming fluid passageways providing fluid communication from one well to another, said apparatus comprising:

for each of at least two of said wells, a remotely accessible conduit extending into the wellhead of such well from a remotely accessible place, said conduits of said wells forming with said underwater conduits a flow line circuit beginning and ending in said remote accessible place, and

a signal emitter in at least one of said remotely accessible conduits adapted to be propelled there-

through to a selected position in said flow line circuit proximate a selected underwater well.

3. The method of claim 1 wherein said signal emitter is propelled first to a position in said flow line circuit proximate a first underwater well in said circuit for location of said first well, and then to a position in said circuit proximate a second underwater well in said circuit for location of said second well.

4. The method of claim 1 wherein said signal emitter is recovered from a second of said remotely accessible conduits after traveling through said flow line circuit.

* * * * *

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 3,866,160

DATED : February 11, 1975

INVENTOR(S) : Charles A. Brasier

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

In the bibliographical data:

Add --[73] Assignee: Exxon Production Research Company, Houston, Tex.--

Signed and sealed this 24th day of June 1975.

(SEAL)
Attest:

RUTH C. MASON
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents
and Trademarks

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 3,866,160

DATED : February 11, 1975

INVENTOR(S) : Charles A. Brasier

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

In the bibliographical data:

Add --[73] Assignee: Exxon Production Research Company, Houston, Tex.--

Signed and sealed this 24th day of June 1975.

(SEAL)
Attest:

RUTH C. MASON
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents and Trademarks