United States Patent

Hyde

[15] **3,681,923**

[45] **Aug. 8, 1972**

[54] **METHOD AND APPARATUS FOR CONTROLLING SUBNATANT OIL SEEPAGE**

[72] Inventor: **Winfield H. Hyde,** 618 Grand Ave., Berkeley, Calif. 94610

[22] Filed: **April 28, 1969**

[21] Appl. No.: **819,805**

[52] **U.S. Cl.** **61/1,** 61/46, 210/170

[51] **Int. Cl.**.....**E02b 3/00,** E02d 23/00

[58] **Field of Search**.....61/1, 465, 46, 69, 81, 82; 14/.5; 8/9; 73/421.5; 210/170

[56] **References Cited**

UNITED STATES PATENTS

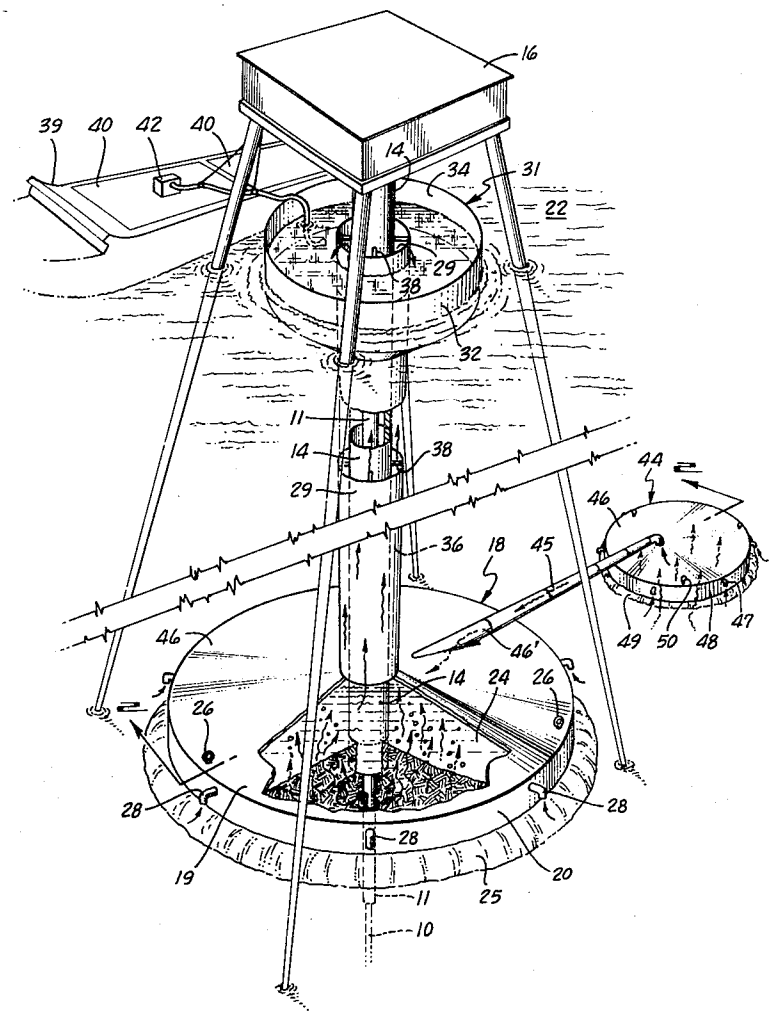
2,112,845	4/1938	Howell	73/421.5
3,500,841	3/1970	Logan	61/72.3 X
3,504,741	4/1970	Baker et al.	166/.5
2,479,787	8/1949	Stevens	73/421.5 X
3,389,559	6/1968	Logan	61/1
3,429,128	2/1969	Stafford et al.	61/46.5
3,469,402	9/1969	Lowd	61/46.5 X

Primary Examiner—Jacob Shapiro
Attorney—Gardner & Zimmerman

[57] **ABSTRACT**

Method of and apparatus for controlling subnatant seepage of oil as from an under water oil well or the like. The method includes the steps of collecting the seepage within an underwater receptacle located along the floor of a body of water in which the seepage occurs utilizing the floor as one of the confining walls of the receptacle. The seepage thus collected is conveyed upwardly in a confined state to the surface of the body of water and is deposited into a receiver from which the collected oil can be transported to a reservoir. The apparatus includes a receptacle open at its bottom to overlie the particular floor area of the body of water at which seepage is or may be present so as to collect or confine the seepage along the floor which serves as the bottom wall of the receptacle. A seepage conduit connected with the receptacle may be disposed circumjacent the outer conduit of an underwater well with which the apparatus is associated, and such conduit functions to carry the seepage from the receptacle to the surface of the water at which it empties into a receiver or reservoir from which the oil is pumped into a container for storage and processing as, for example, separation of the oil from water admixed therewith.

3 Claims, 4 Drawing Figures



PATENTED AUG 8 1972

3,681,923

SHEET 1 OF 2

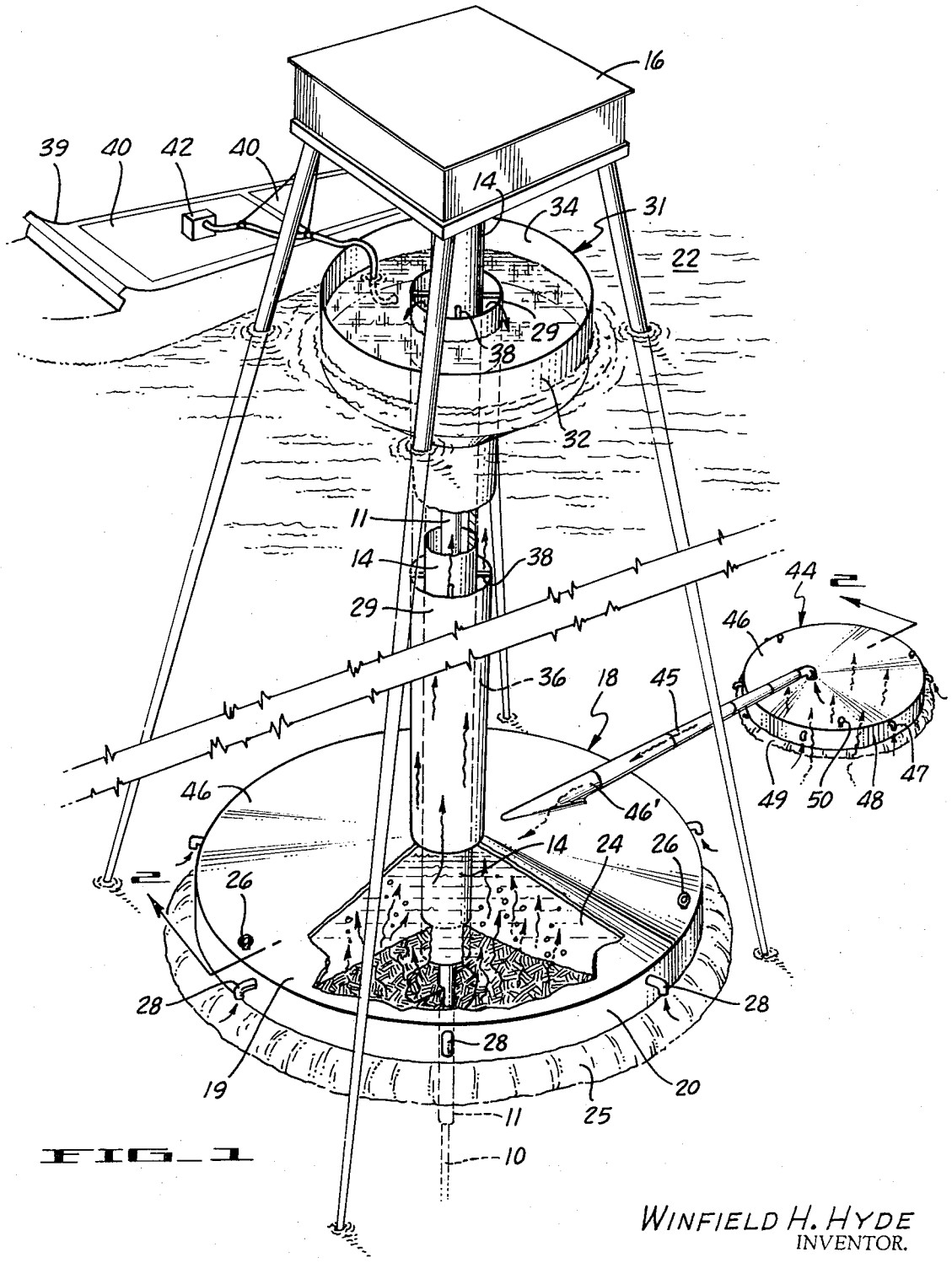


FIG_1

WINFIELD H. HYDE
INVENTOR.

BY Gardner & Zimmerman
ATTORNEYS

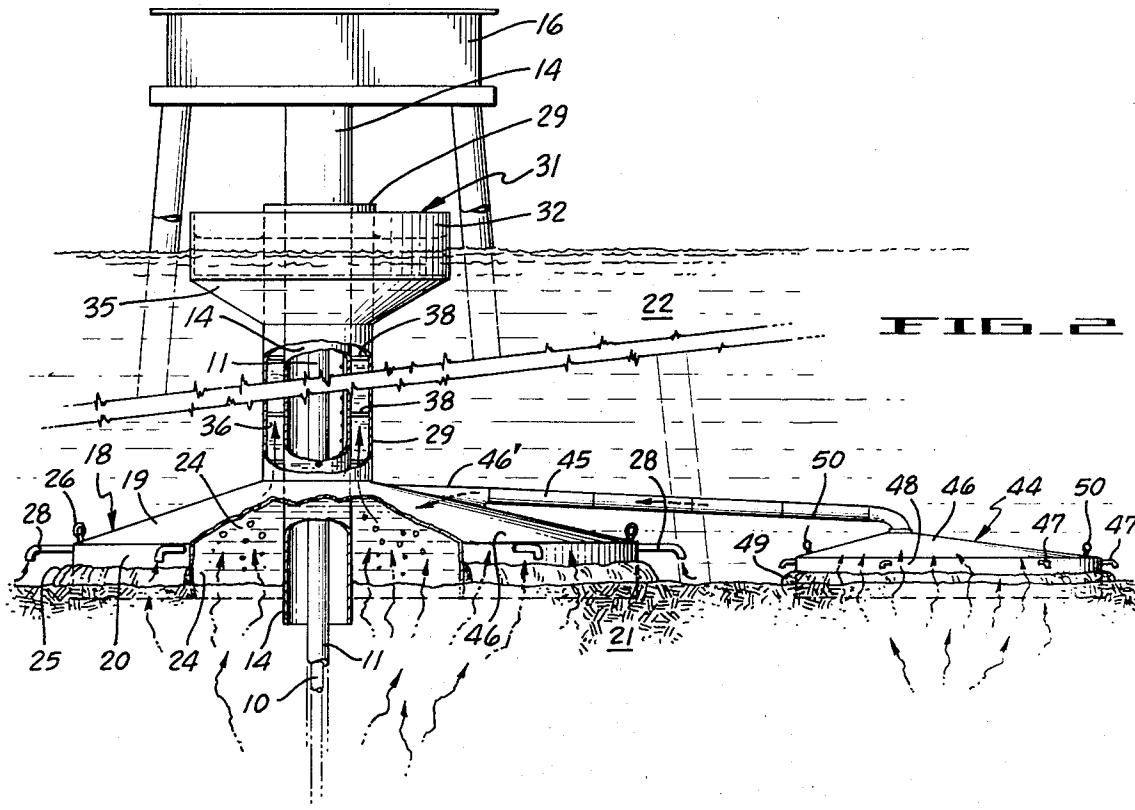


FIG_2

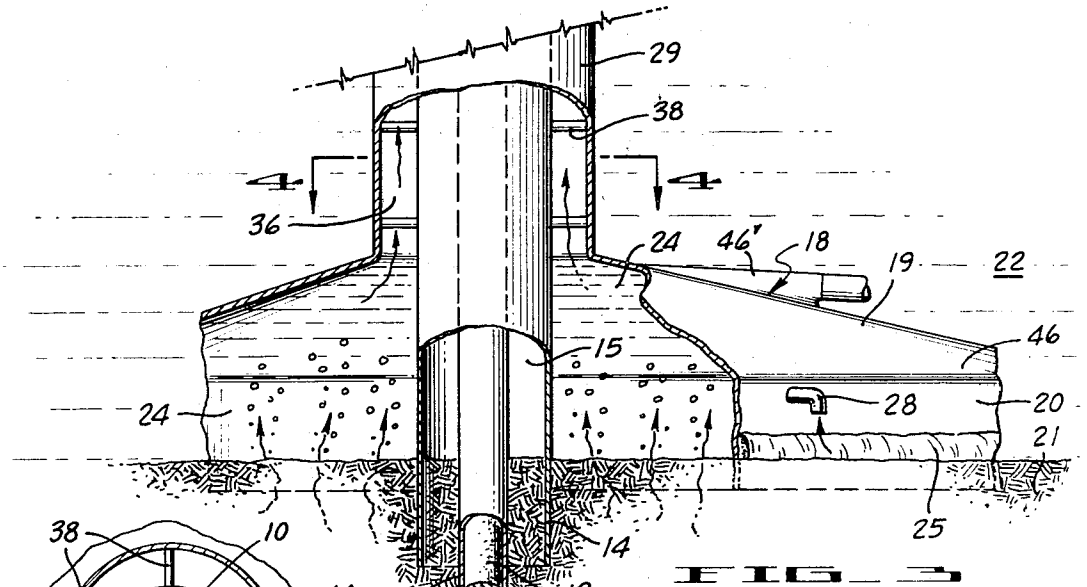


FIG_3

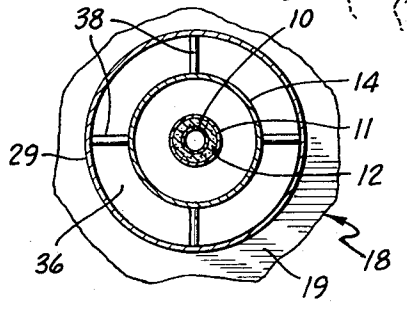


FIG_4

WINFIELD H. HYDE
INVENTOR.

BY Gardner & Zimmerman
ATTORNEYS

METHOD AND APPARATUS FOR CONTROLLING SUBNATANT OIL SEEPAGE

This invention relates to means for controlling underwater oil leakage and, more particularly, to a method of and apparatus for controlling subnatant oil seepage as from an underwater well or the like.

Underwater oil seepage may be occasioned by the upward escape of oil under high pressure through cracks and other fissures in the underground rock structure containing the oil, and which cracks are known to exist in large numbers in zones where earth movement has occurred. Even zones which in a contemporary sense are quiescent may have experienced earth movement in the past causing cracks which eventually give way to the high-pressure oil and finally result in seepage thereof. Since such rock structure is below the floor of the body of water and is most frequently covered with sediment and debris of considerable depth, there is no effective way to determine the condition of the concealed rock structure or predict when oil seepage may occur.

Also, even under the most favorable conditions where every reasonable precaution has been taken, offshore oil wells may be damaged or otherwise become faulty and permit seepage or leakage of oil into the surrounding water. For example, storms sometimes damage oil well structures and occasional collisions with water craft severely damage an oil well structure. In either case, seepage may occur adjacent the floor underlying the body of water, and such seepage is very difficult to contain and control by known techniques which essentially involve plugging the crack with a sealing material such as concrete.

As is commonly known, oil seepage of any significant extent causes much damage and great inconvenience, the essential reason therefore being that the oil so escaping does not remain localized. In this respect, oil is much lighter than the water into which it escapes, having a specific gravity of about 0.91 to 0.93 relative to sea water which has a specific gravity of about 1.02 to 1.03, and therefore tends to rise to the surface of the water where it is distributed widely as a consequence of surface conditions including both natural wave action of the water and surface movement thereof caused by winds acting thereon.

In view of these difficulties, it is generally advantageous to provide effective means for controlling subnatant seepage of oil, and it is accordingly an object, among others, of the present invention to provide a method of an apparatus for so controlling such oil seepage.

Another object of the invention is in the provision of an improved method of and apparatus for controlling subnatant seepage of oil such as from an underwater well or the like, and which method and apparatus are sufficiently versatile, simple, and relatively inexpensive that they can be used both in an emergency sense to control leaks that may occur in association with oil wells already in existence and in a sense of permanency as a part of an oil well installation constructed either at the time that a well is driven or added to an existing well.

Still another object is that of providing an arrangement of the character described in which any such seepage is collected within an underwater receptacle positioned along the particular area underlying the body of water at which seepage does or may occur, and which receptacle is in the form of a cap or umbrella overlying the area of seepage and utilizes the underlying floor area as the bottom wall of the receptacle.

A further object is to provide for conveyance of the oil (and any admixture of water or other substances therewith) in a confined state from the receptacle at the floor of the body of water to a receiver at the surface thereof such as through a seepage conduit, and which seepage conduit and receptacle may each be generally circumjacent the outer well conduit, the seepage conduit at its upper end being connected to a receiver located at the surface of the body of water and into which receiver the seepage is discharged.

Additional objects and advantages of the invention, especially as concerns particular features and details thereof, will become apparent as the specification develops.

An embodiment of the invention is illustrated in the accompanying drawings in which:

FIG. **1** is essentially a perspective view of apparatus embodying the invention shown in association with a submarine oil well;

FIG; **2** is a combination side view in elevation and transverse sectional view of the apparatus taken along the line **2—2** of FIG. **1**;

FIG. **3** is an enlarged, broken side view in elevation, with parts broken away and shown in sections, of a portion of the apparatus; and

FIG. **4** is a transverse sectional view taken along the line **4—4** of FIG. **3**.

As indicated hereinbefore, the invention is concerned both with a method of controlling subnatant or underwater oil seepage and with an apparatus therefor. In the usual case, the apparatus will be associated with a submarine or underwater oil well although it is applicable to situations in which seepage occurs independently of or without derivation from such well. In either case, the apparatus functions to control the seepage by collecting or confining it within a receptacle located along the floor of the body of water in which the subnatant seepage occurs and by transferring the seepage to a remote location for deposition within a suitable container. In the drawing, the apparatus is illustrated in association with an oil well, but as respects the present invention the oil well, both in terms of structure and function, may be completely conventional and per se is not germane to the present invention.

Although conventional, the illustrative oil well shown in the drawings will be described briefly for purposes of general orientation and to provide a convenient reference for the structural association of the seepage control apparatus therewith. Accordingly, and as seen most clearly in FIG. **4**, the oil well has the usual conductor tube or pipe **10** driven into the ground to an oil bearing strata or elevation, and it extends upwardly therefrom to a location above the surface of the water so as to carry oil from the oil-bearing depths to a reservoir or other storage or processing means located at the water surface. Circumjacent the conductor tube **10**, is a surface casing **11** that also projects into the ground below the surface of the water but not necessarily to the same depth as that of the conductor tube **10**. The space defined between the inner and outer conduits **10** and **11** is usually filled with a material such as concrete

or sand and the choice may depend upon the particular elevation at which the material is to reside. In FIG. 4 such space-filling material is indicated by the numeral 12. In a typical oil well, the conductor tube 10 may have a diameter of from 16 to 36 inches and, evidently, the casing 11 must have a somewhat greater diameter since it confines the tube 10 therewithin.

Surrounding the casing 11 is an outer conduit 14 that is often referred to as a snorkel tube because it extends upwardly from an embedded condition within the ocean floor (or floor of any other body of water) to a location above the body of water to provide an atmospheric environment within its interior. That is to say, the snorkel tube 14 is evacuated of water so as to be free therefrom, and irrespective of its length provides an atmospheric environment in which personnel may work both to install the necessary pumping and ancillary equipment and thereafter to maintain the same. Apparently then, the snorkel tube 14 must have a substantial diameter, and in most cases, the diameter thereof is within the range of about 36 to 72 inches, and the wall thickness of the tube will depend upon its diameter and the pressure forces it is to withstand and by way of example is most frequently in the range of from three-fourths of an inch to 2 inches. For purposes of simplifying the drawings, the usual well equipment has been omitted from the large space 15 defined between the casing 11 and snorkel tube 14, although in FIG. 1 the usual ladder with which the snorkel tube is equipped is partially shown.

The snorkel tube 14 or any other outer conduit provided by the oil well is sometimes referred generally hereinafter as the "well conduit" or "outer well conduit", and it is a very stable structure driven into the ocean bed to a depth (generally to the point of resist) at which it is quite rigid and requires little, if any, support intermediate the ocean floor and the surface of the body of water thereabove. At its upper end, the outer well conduit usually provides the support for a platform or rigging depicted only generally in FIG. 1 and denoted with the numeral 16. As indicated hereinbefore, respecting the present invention the oil well may be conventional and the brief description thereof given is in no sense intended to be definitive but only generally descriptive and is included for environmental purposes.

The seepage control apparatus includes a main receptacle 18 having a top well 19 and depending side walls 20. The side walls 20 are adapted to seat against and perhaps penetrate to some depth (as shown in FIG. 3) the floor or bed 21 underlying the body of water 22 with which the control apparatus is associated. Thus, the floor or bed 21 forms the bottom wall of the receptacle 18 and defines with the top and side walls 19 and 20 thereof a chamber 24. Desireably, ingress and egress of liquid into and out of the chamber 24 from about the lower edge of the side walls 24 is inhibited, and for this purpose a base seal 25 of mud or concrete is provided along the side wall adjacent the floor 21.

The receptacle 18 may be as large as necessary or desired and it is intended to overlie the floor area at which seepage of oil occurs. Quite frequently, such seepage appears in the vicinity of an oil well or in close proximity thereto and, therefore, the receptacle is conveniently disposed in circumjacent relation with the oil well and particularly with the outer conduit thereof. Depending on its size and the depth at which it is to be positioned, the receptacle 18 may be constructed under water or it may be constructed in whole or in part above water and lowered into position. For this purpose, the receptacle may be provided with a plurality of connectors or lowering rings 26 which may be secured to the top wall 19 and are adapted to have cables releasably affixed thereto by means of which the receptacle can be lowered.

The receptacle 18 need not be constructed of materials having the great strength required to withstand considerable pressure differences because the chamber 24 is to be filled with liquid so as to have within its interior the pressure existing at the elevation at which it is located. For this purpose (and to facilitate seepage flow as described subsequently) the receptacle 18 is provided with a vent means in open communication with the body of water 22, and such vent means may take the form of one or more conduit-equipped openings 28.

A seepage conduit 29 is connected with the receptacle 18 for removing oil (i.e., usually a mixture of oil and water) from the chamber 24 and for conveying such liquid mass to a suitable container located remote from the receptacle. In the apparatus shown, such seepage conduit 29 is circumjacent the outer well conduit 14 and connects with the receptacle 18 through a large opening 30 in the top wall 19 thereof. The seepage conduit extends upwardly to an elevation above the level of the water 22 and communicates thereat with a container which, in the form shown, is a receiver 31 that surrounds the upper end portion of the conduit and has a side wall 32 that rises to a height above the surface of the body of water so that wave action and any other surface disturbances will not interfere with the contents of the receiver chamber 34 defined in part by the side wall 32 and in part by a bottom wall 35 that converges inwardly and downwardly from the side wall and is fixedly secured to the conduit 29 so as to prevent ingress and egress of water into and from the chamber 34 from about the conduit 29. As shown, the receiver 31 is partially immersed in the body of water 22 and is therefore at least in part supported by the buoyance thereof.

Since the seepage conduit 29 conveys liquid from the receptacle 18 to the receiver 31 it will be appreciated that a substantially unobstructed flow passage must be defined within the conduit. As explained heretofore, the conduit 29 is circumjacent the outer well conduit 14 and, accordingly, the seepage conduit must be somewhat larger in diameter than the well conduit so as to define a flow space or passage 36 therebetween. However, because of the relatively large diameter of these two conduits, it is not necessary that the diameters thereof differ greatly in order to establish a large-area flow space of adequate capacity. The symmetry of such space 36 is permanently established by guide or support structure 38 interposed therebetween the conduits within the flow space 36.

Such guide structure or stabilizing means may take any convenient form and in the apparatus illustrated, it constitutes a plurality of angularly spaced spider structures or spacers located at each of a plurality of vertically spaced locations along the length of the conduit 29. Each of the spacers 38 may be welded or otherwise fixedly secured in position as shown best in FIG. 4. As

in the case of the receptacle **18**, the seepage conduit **29** need not be constructed of exceptionally strong material since there is essentially no pressure differential as between the interior and exterior thereof. However, the presence of the spacers **38** serves to reinforce and thereby stiffen the conduit **29**. Depending upon the particular environment, the conduit **29** may be either rigid or flexible.

Oil may be transported from the receiver chamber **34** to a suitable reservoir which can take any convenient form and may be located in the body of water **22** so as to be relatively proximate the receiver **31** or it might be located on shore. As shown in FIG. **1**, the reservoir is provided by a barge **39** which may support or be subdivided into a plurality of containers **40** which are flow connected with the receiver **31** by a conduit or pipe system **41** that usually will include a suitable pump mechanism generally indicated with the numeral **42**. The pump mechanism **42** may be mounted upon the barge **39** or, in certain instances, may be supported on the rigging or platform **16** of the oil well.

In certain cases, a fissure through which oil seeps to the surface of the floor **21** may occur at a location not enclosed within the main receptacle **18** but may be sufficiently close thereto that the facilities of a control apparatus already installed can be utilized in controlling the seepage. In such cases, it may be advantageous to construct or lower, as the case may be, a satellite or auxiliary receptacle **44** onto the floor **21** underlying the body of water **22** and to connect such satellite receptacle to the main receptacle **18** by a suitable flow conduit or duct **45**. In anticipation of this possibility, the main receptacle **18** may be provided with one or more openings **46'** therealong that are ordinarily capped but which can be opened and connected with such ducts **45** should this be required. Evidently, one or more satellite or auxiliary receptacles **44** may be employed in association with any main receptacle **18** and in terms of its essential structure, each may be a substantial duplicate thereof.

Thus, each receptacle **44** may have a top wall **46** and depending side walls **48** adapted to seat against the floor **21** and be sealingly related thereto by concrete or other seal means **49**. A plurality of connectors or lowering rings **50** are provided along the top wall **46** for purposes of lowering the receptacle **44** as heretofore explained with reference to the receptacle **18**. Each auxiliary receptacle **44** may be equipped with vent means **47** as heretofore explained although in some instances the vent means associated with the receptacle **18** may be relied on for pressure equalization within the receptacle an free upward flow of seepage through the conduit **29**.

The seepage control apparatus is conveniently installed or erected at the time that an oil well is constructed, but as explained hereinbefore, it can be built in structural association with an oil well already in existence and for this purpose any conventional construction techniques usually employed in the oil well industry can be followed.

In the event that there is no oil leakage or seepage in the area about the well, the control apparatus is essentially dormant and requires substantially no attention or maintenance. In its dormant state the chamber **24** of the receptacle **18** will be substantially filled with water and so will the flow space **36** defined between the outer well conduit **14** and seepage conduit **29**. Similarly, the receiver chamber **34** may be at least partially filled with water and any movement throughout the seepage system of the control apparatus will be quite limited and of a rather relatively minor nature.

Should seepage occur within the receptacle **18**, or within one or more auxiliary or satellite receptacles **44**, the oil thereby entering the receptacle **18** either directly or indirectly will rise upwardly through the receptacle and seepage conduit **29** and discharge into the receiver **31** either because of the difference in the specific gravity of oil and water (0.91 to 0.93 for oil and 1.02 to 1.03 for sea water) as explained if the seepage is slight or at a low volume or, in the case of the seepage into the receptacle **18** being at a high rate and therefore under relatively high pressure, the oil will tend to displace the water from the receptacle **18** and flow space **36** within the seepage conduit **29** until the discharge from the seepage conduit into the receiver **31** is substantially all seepage oil. In either case, the liquid within the receiver chamber **34** should eventually become predominately seepage liquids and may be pumped or otherwise transported from the receiver chamber to the reservoir **40**.

Pressure equalization is afforded by the vents **28** and such venting may be of importance particularly if positive pumping apparatus is arranged with the seepage conduit **29** to remove liquid therefrom in which event a slightly reduced pressure (which might become vacuous in the absence of vents) may be present within the conduit relative to the water pressure exteriorly thereof. As a consequence, it is desirable to provide relatively water-tight connections along the seepage conduit **29** and at the points of connection thereof with the receptacle **18** and receiver **31**.

It will be evident that control of subnatant seepage of oil from an underwater well is effected by collecting or encapsulating the seepage within a receptacle that is located along the floor of the body of water in which the seepage occurs, and by conveying the oil to a receiver or other container located remotely from the receptacle and then depositing the conveyed oil into such receiver. Encapsulation of the seepage prevents general migration or spread thereof within the body of water and further prevents general distribution or transport by the wave action and other motion of the water. The floor underlying the body of water is used to form part of the receptacle within which the seepage is collected, and conveyance of the oil from the receptacle to a receiver therefor is accomplished by confining the oil as within a conduit.

The technique and apparatus characterizing the same are quite versatile and can be used to control seepage that occurs adjacent a submarine well not equipped with the apparatus and also to control seepage about a naturally occuring fissure having no association with a well. Since the apparatus is structurally simple, it is relatively economical to install and maintain and, therefore, can be used practicably as a permanent part of any underwater oil well installation.

While in the foregoing specification, an embodiment of the invention both in apparatus and method terms has been set forth in considerable detail for purposes of making a complete disclosure thereof, it will be ap-

parent to those skilled in the art that numerous changes may be made in such details without departing from the spirit and principals of the invention.

What is claimed is:

1. In combination: apparatus for controlling subnatant escape of oil within a body of water as from a submarine well or the like, comprising a receptacle generally open at its bottom and having wall members engageable with the floor beneath such body of water to define with such floor an essentially closed chamber adapted to collect escaping oil therewithin, and a seepage conduit connected adjacent its lower end with said receptacle in communication with said chamber for removing oil therefrom; and an underwater well having an outer well conduit extending upwardly through said chamber and centrically through said seepage conduit in substantial flow isolation therewith from the floor beneath such body of water to a location adjacent the surface thereof; said chamber being materially larger in cross sectional area than said well conduit and having a relatively large volumetric capacity so as to accommodate a large-volume escape of oil occurring within said receptacle.

2. In combination: apparatus for controlling subnatant escape of oil within a body of water as from a submarine well or the like, comprising a receptacle generally open at its bottom and having wall members engageable with the floor beneath such body of water to define with such floor an essentially closed chamber adapted to collect escaping oil therewithin, and a seepage conduit connected adjacent its lower end with said receptacle for removing oil therefrom; and an underwater well having an outer well conduit extending upwardly through said chamber in substantial flow isolation therewith from the floor beneath such body of water to a location adjacent the surface thereof; said seepage conduit being generally circumjacent said well conduit.

3. The apparatus of claim 1 in which said chamber is materially larger in cross sectional area than said well conduit and has a relatively large volumetric capacity so as to accommodate a large-volume escape of oil.

* * * * *