ABSTRACT OF THE DISCLOSURE

The invention relates to a self contained submersible structure adapted to be lowered through a body of water to form a provisional passage for crude oil and/or gas escaping from a well or substructure fissure. The structure includes a support frame forming a fluid guiding and entraping means, together with a collapsible conduit which communicates the source of escaping fluid with the water's surface whereby to form a confined pool.

OBJECTS OF THE INVENTION

It is therefore one of the objects of the invention to provide a means for quickly and economically overcoming an air and water pollution situation precipitated by an uncontrolled flow of gas or crude oil from an under water source. A further object is to provide an apparatus adapted to be readily communicated with an under water source of escaping gas and/or oil whereby the uncontrolled flow might be channeled to a storage or separating system. Another object is to provide a device of the type contemplated which is portable, and readily initiated into use within a brief lapse of time subsequent to the discovery of oil leakage. Still another object is to provide a self contained capping apparatus adapted to be lowered onto a subsea fissure or source, whereby fluids escaping under pressure might be directed through a confined passage to the water's surface. A still further object is to provide an apparatus of the type contemplated wherein a collapsible conduit is lowered to a subsea fissure or fluid source whereby to enclose the source of escaping fluids and channel the latter through a conduit to the water surface for separation.

In achieving the foregoing objectives, and in overcoming the herein mentioned problems, there is presently provided a mobile apparatus adapted to be lowered to an under water location thereby forming an escape route for gas and/or crude oil. The device includes means for firmly anchoring the apparatus at the under water location, and a flexible conduit. The latter is collapsibly retained in such manner to occupy a minimum of space during periods of storage and descent of the apparatus to the ocean floor. The closed conduit, or canopy as it is referred to, incorporates a float mechanism adapted to carry the upper end thereof to the water's surface while the lower end is fluid tightly attached to a carrying frame whereby to receive the flow of escaping fluid.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 illustrates pictorially, an embodiment of the submersible vehicle being suspended from a surface craft above an aperture in the earth's surface. FIG. 2 is an illustration of the submerged apparatus in operating condition with the canopy extending from the under water source of fluid to the water's surface. FIG. 3 is an elevational view in cross section of the present apparatus with the canopy in collapsed position. FIG. 4 is similar to FIG. 3 with the canopy shown in extended position and the pile anchors imbedded into the substratum. FIG. 5 is a segmentary view in cross section illustrating the upper end of the expanded canopy with a means forming a gas enclosure about the oil pool.

Referring to the drawings, an embodiment of the presently contemplated flow control apparatus is shown in FIG. 1 in a partially submerged position, being supportedly guided by cables 15 from a floating barge 12, while being lowered onto a fluid escaping fissure 13 at the ocean floor. The device includes a frame formed of structural and buoyant members. A fluid gathering, funnel shaped collector 14 as well as a collapsed canopy 16 are carried on the frame.

Canopy 16 is stored and retained in a collapsed condition as the frame is lowered to the ocean floor. Thereafter, and as shown in FIG. 2, canopy 16 is released from its storage compartment and drawn to the ocean's surface by a float collar 17. The canopy thus defines a closed, flexible passage communicating the minimum fluid source and the water's surface. Normally, a pool comprising a mixture of water and crude oil is gathered at the upper end of the nonrigid passage. The pool is continuously and controllably evacuated by a floating pipe line 19 connected to a pumping system carried on adjacent anchored barge 18.
Crude oil is then extracted from the mixture, stored in the barge, and the water returned to the ocean.

To facilitate proper functioning of conduit 16, the latter, because of Fig. 11, is provided with a plurality of longitudinally spaced support rings 21 which partially rigidize and strengthen the conduit. Guide cables 11 carried on a reel type takeup 27 on the frame, interconnect the respective rigidizing rings to float collar 17 whereby the ascent and descent of the latter is remotely controlled. The support frame includes a base formed of buoyant members such as cylindrical tubes 23, 24 and 26 connected at their respective extremities to define a lower peripheral enclosure. Means is incorporated into the base for anchoring the unit to the substrate of a body of water. The anchoring means may take the form of any of several appropriate devices such as piling or the like.

In the present arrangement, where the substrate is sufficiently fluid to permit the entrance of a pile anchor, one or more of the latter are used. To accommodate the anchors, each corner of the frame base is provided with a remotely controlled jacking mechanism 27 and 28 operably engaged with a pile anchor 29 and 31 registered vertically in said mechanism and having an open end at the frame lower side.

Pile anchor 29 is of a familiar structure and comprises in essence an elongated fluid tight cylindrical body having a lower open end 32 and a closed weighted upper end 33. The upper end is communicated by an exhaust valve or fitting 34 having an outlet adapted to receive a hose 36 or similar member extending through the water's surface. Thus, by regulating the internal atmosphere of the pile anchor from the water's surface, the latter can be drawn into a fluidlike substratum to a sufficient holding depth. For a more firm substratum, this type of anchor would of course be inapplicable in which instance driven piles could be employed.

Jacking mechanism 27 operably connected to pile anchor 29, includes a ratchet or similar mechanical device adapted to engage longitudinally spaced grooves on the pile periphery. Thus, remote actuation of the jacking mechanism permits the pile to be adjusted up or down as needed to bring the frame into fixed, substantially tight engagement with the usually soft upper layer of the substratum.

A fluid guide, positioned within and held by the support frame, includes the funnel-like collector 14 having a relatively broad open rim disposed adjacent to the base lower end. The inwardly tapered walls of collector 14 define a substantially frusto-conical figure which leads to, and terminates at a relatively constricted opening 36 at the upper end. An upwarding passage 37 defined by a cylindrical retainer 38 extends from collector 14 being attached at opening 36.

A storage compartment 39 for collapsible canopy 16 held within the support frame, includes an upwardly extending cylindrical shell 41 having the lower edge connected to the outer surface of collector 14 at a peripheral joint 42. Annular compartment 39 defined between spaced apart walls of shell 41 and retainer 38, is adapted to receive canopy 16 in a collapsed condition on the compartment's lower bulkhead 43. There the canopy is stored prior to being put into use for collecting a fluid flow to the water's surface. Canopy compartment 39 is shown positioned centrally of the support frame by a plurality of structural members and braces such as 44 and 46 extending from the base inwardly to engage the outer wall of shell 41.

The function of canopy 16 as herein noted is twofold, i.e., to be stored initially in collapsed condition, and thereafter in an expanded condition to form an elongated closed passage extending from the ocean floor to the water's surface. Canopy 16 thus comprises a cylindrical member having an inlet opening at the lower end connected to the inner edge of storage compartment 39 at bulkhead 43. The canopy remote end is disposed adjacent the storage compartment upper end.

The nature of the supporting frame, and canopy storage compartment such as to accommodate canopies of varying lengths. When the unit is stored at a surface location therefore, it need not hold any canopy until such time as it is to be put into use at a known water depth. For undersea storage however, the canopy will be stored at all times on the unit.

In the instance of a torus shaped storage compartment 39, a flotation member such as a circular, inflatable float collar 17 is connected to the upper end of canopy 16 to define the canopy outlet. Float 17 may assume any of a variety of controllably buoyant members such as a rubber inflatable ring, or even a rigid enclosure member formed of circularly arranged steel tanks having controllable chambers. In the latter instance, a pumping system is provided to regulate the buoyancy of the chambers by liquid transfer, whereby the ring is caused to raise from the ocean floor, or descend to the latter as the situation demands.

Canopy 16 as mentioned, is preferably although not essentially, formed in an elongated cylindrical configuration of a flexible material, such as filled rubber or Neoprene, canvas, reinforced plastic or the like. Essentially, the canopy material is of course water resistant and adapted to retain its flexibility over a temperature range so as to be found in offshore waters. The consistency of the canopy wall is preferably such as to permit the entire body to be readily collapsed into folded form within compartment 39, and exhibit a minimum degree of stretchability.

Inner rings 48 carried on the canopy provide means for coupling the consecutively positioned canopy sections into a continuous elongated passage. The spherical-like configuration of the individual sections permits the most efficient storage of a maximum length of canopy within a minimum volume of compartment 39. As shown in the figures, with canopy 16 folded, inner ring 48 is disposed immediately adjacent to retainer wall 38, while outer ring 49 is disposed adjacent to the shell 41 wall, permitting cable 11 to be registered in alignment within the vertically arranged rings.

To best lend itself to convenient storage as well as structural rigidity, circular reinforcing rings 48 and 49 connected at spaced intervals to the canopy outer surface, facilitate the canopy being folded into annular storage compartment 39. Outer rings 49 carried on the major diameter include a plurality of peripherally spaced guide loops 51 adapted to slidably received cables 11. When normally folded into stored position, canopy 16 is arranged or otherwise collapsed into compartment 39 such that the respective support ring guide loops 51 lie adjacent the inner wall of shell 41 with cables 11 registered in successive loops.

Canopy 16 guide and restraining means comprises the circularly arranged and upwardly extending cables 11 which function to firmly connect inflatable collar 17 to the floor anchored structure. Simultaneously, the cables exert a lateral restraining force to the otherwise resilient canopy passage. Thus, each guide cable 11 is coiled on a controlled drive reel 52 carried on the frame. Reel 52 is connected through a transmission means to motor means, which in turn is regulated from the water's surface. Guide cables 11 passing from reel 52, slidably register through a sleeve 53 transversing the wall of shell 41, and terminating at the interior side thereof. The cable is further received as mentioned in the respective loops 51 of the circular rigidizing rings 49 and is connected at its remote end to float 17. Although four guide cables 11 are presently shown, any suitable number may be so employed depending on the diameter of the canopy passage and water depth in which the apparatus is used.

Normally, sea water will freely enter through ports 20 or openings about the base, thereby intermixing with oil and gas passing upwards through the enclosure of collector 14. Since the fluid pressure on the interior and exterior...
sides of canopy 16 will be substantially equal, the walls of canopy 16 will be subject to no excessive strain other than the upward pull exerted by float collar 17 and the lateral displacement caused by sides or water currents. In actually the flow rate of fluid through the canopy passage can be regulated to some extent by the rate at which the pool at the top is pumped out.

Operationally, the herein described structure including canopy frame may be stored on land or at the ocean floor. In either instance the unit is so positioned to be available for movement on short notice to a location where an oil or gas leak has suddenly occurred beneath the water’s surface. In the instance of a relatively extensive oil field in an area that is susceptible to surface fractures or fissures, the unit can be submersed and stored at the field. However it might also be positioned at a location where it would be accessible to be immediately transported either by boat or by helicopter to where an emergency has occurred. Further, the support frame is structurally self-sufficient to the point where it is floatable by evacuating the respective tanks in the base unit. Thus the unit can be also floated and towed to a working location.

Normally the location of an oil or gas leakage is characterized by relatively dense crude oil forming a discoloring slick at the water’s surface. However, in the instance of a gas leakage the surface above the leaking source will be characterized by turbulence due to the gas bubbles rising to the surface, expanding and bursting. It is appreciated that the surface disturbance need not be directly above the floor fissure itself since the water current prevalent in the area will have a tendency to displace the oil and/or gas stream in a lateral direction. Descents of the apparatus through a body of water, as shown in FIG. 1, is controlled at least in part by lifting support from a derrick, winch or similar apparatus carried on the surface barge. Controlled flooding of the base buoyancy chambers during lowering will cause the entire unit to sink slowly toward the ocean floor. Accurate positioning such that collector 14 forms a closure across the underwater fracture, may be achieved with the aid of divers, television guidance, or other suitable ways for assuring that the collector seats properly as to substantially enclose the leak area.

Upon reaching the desired ocean floor position, thereby forming a substantial closure across the fissure, the support frame is anchored. This as previously mentioned may be achieved by using the peripherally spaced pile anchors into the substratum if the consistency of the latter so permits. In a more consolidated clay-like substratum, until now the base and only such limitations would suffice to hold the frame at the required spot.

When the leaking aperture is so confined, escaping oil and/or gas together with sea water will rise through the collector 14 to be deflected into the central opening 36. To form the vertical oil flow passage to the surface, float ring 17 is inflated by evacuation to a degree whereby it will rise to the surface thus withdrawing the collapsed canopy 16 from storage compartment 39. During canopy extension phase of the operation, the tension on guide cables 11 is controlled whereby the upward velocity of the ring is controllably regulated.

When float collar 17 reaches the water’s surface its position can be regulated by the tension exerted on the guide cables, anchoring lines or other means. However it is appreciated that because of the water surface turbulence, and currents acting against the sides of the now extended flexible conduit, cables 11 will permit the conduit to be resiliently displaced. Thus, the combined freedom of movement of floating collar 17 itself, together with the longitudinal resiliency of the canopy float ring 17 will permit maintenance of a relatively confining pool for rising crude oil in spite of surface wave motion. When successfully confined to a limited area within float collar 17, means is provided to remove the oil-water mixture to separating equipment at barge 18.

As shown in FIG. 5, a flow head 56 is connected to the float collar 17. Flow head 56 includes a retainer or collar 57 which is firmly received in receiving rim 58 depending from collar 17 upper side. Said flow head embodies a suction tube 59 the inlet thereof depending downwardly from platform 57 to a point below the water’s surface. The suction tube 59 upper end is connected to platform 57 at a suitable coupling and preferably at a swivel type connection 61 to permit respective movement of a coupling in response to movement of the water and the float ring. Coupling 61 engages transfer conduit or floating pipe 19 for carrying oil to the separating equipment.

When it becomes apparent that the flow of escaping fluids has been stemmed or the leak fissure has been plugged, canopy 16 may be withdrawn into its storage compartment 39. Further, as the flow becomes minimized and appears to be controllable, the float collar 17 may be provided with a cover 66 which, when connected to the float collar 17, will in effect form an enlarged chamber for accumulating escaping gas. One or more enlarged exhaust openings 67 and 68 are formed in the walls of said cover 66 and are provided with flow control valves or regulating equipment such that the flow of gas can be gradually brought under control. Cover 66 may be provided with resilient or blow out panels to release sudden surges of gas.

Thus as the said escaping flow decreases the entire canopy 16 is withdrawn into its storage compartment 39 by the combined downward pull of cables 11 together with a reduction of the buoyancy of flow collar 17. Conduits or pipes connected to the respective outlets 67 and 68 then carry gas from the ocean floor up to a collecting point. Similarly, liquid carrying conduit 19 connected to the liquid separating barge 18 continues the withdrawal and storage of usable products.

For salvaging the apparatus in anticipation of future use, with the canopy folded into position within compartment 39, the apparatus is dislodged from its resting spot on the ocean floor and floated to the surface. In the instance of pile anchors, the latter are of course withdrawn from their imbedded position by the regulation of the anchor’s interior pressure. In the instances of ordinary piles, they are severed explosively, in either instance the apparatus is floated to the water’s surface and removed by barge or floated away for storage until subsequent use is required.

Other modifications and variations of the invention as hereinbefore set forth may be made without departing from the spirit and scope of the invention, and such modifications and variations are intended to be within the scope of the appended claims.

We claim:
1. Provisional control apparatus for confining an upwardly flowing uncontrollable stream of fluid escaping from an under water source, which apparatus includes:
   a. a support frame having a base adapted to engage the subsea floor at said fluid source to position said frame;
   b. a collector carried on said support frame, having an intake opening disposed adjacent to said base to provide a substantial enclosure about said fluid source and to receive a fluid flow therefrom,
   c. an elongatable collapsible canopy having opposed inlet and outlet ends communicated by means forming a passage therebetween, said inlet end being connected to said collector, and said outlet end being of sufficient length when in elongated condition to extend said means forming said passage outlet to the water’s surface, whereby said fluid flow will accumulate to form a pool.
2. In an apparatus as defined in claim 1 wherein; said collapsible canopy includes an elongated cylindrical body having flexible side walls defining said means forming said passage.
3. In an apparatus as defined in claim 1 wherein; said
collapsible canopy includes an elongated cylindrical body formed of flexible side walls and having longitudinally spaced rigidizing rings connected circumferentially to said side walls.

4. In an apparatus as defined in claim 1 including; a float collar connected to said collapsible canopy outlet end and adapted to controllably traverse a water distance between said support frame and the water's surface.

5. In an apparatus as defined in claim 4 wherein; said float collar includes a ring-like member connected to said collapsible canopy outlet end and defining an opening therefor for said conduit pool.

6. In an apparatus as defined in claim 1 including; means forming a compartment for storing said canopy in collapsed condition.

7. In an apparatus as defined in claim 6 wherein; said compartment includes an upstanding retaining wall, a peripheral shell spaced from said wall, the lower end of said respective retaining wall and shell being connected to said collector thereby defining an annular upstanding compartment for receiving said canopy in collapsed condition.

8. In an apparatus as defined in claim 1 including; extendable guide means carried on said frame and connected to said float collar to form a restraining barrier to said canopy when the latter is in the extended condition.

9. In an apparatus as defined in claim 8 wherein; said guide means includes a plurality of cable holding reels carried on said frame the respective cable ends being connected to said float collar.

10. In an apparatus as defined in claim 9 wherein; said respective cables are slidably connected to the outer surface of said canopy wall.

11. In an apparatus as defined in claim 9 including; means for controllably varying the length of said respective guide cables whereby to regulate movement of said float collar when traversing said body of water.

12. In an apparatus as defined in claim 1 wherein said collector includes; a lower edge forming a tapered wall defining said intake opening, and terminating at a constricted discharge port whereby said fluid flow will be directed upwardly along said tapered wall and passed through said discharge port.

13. In an apparatus as defined in claim 1 wherein said collector includes; a funnel-like member having a broad intake opening disposed adjacent to said base and being contiguous with the ocean floor, and including a constricted outlet extending in a generally upright direction.

14. In an apparatus as defined in claim 13 including; a cylindrical retaining member connected to and extending upwardly from said collector thereby defining a central flow passage from said discharge port.

15. In an apparatus as defined in claim 3 wherein; said rigidizing rings include a loop member adapted to slidably receive a guide cable passing therethrough.

16. In an apparatus as defined in claim 15 wherein; said respective rigidizing rings include at least three sliding members disposed peripherally about said canopy wall.

17. In an apparatus as defined in claim 1 wherein; said support frame base includes a buoyancy element incorporated therein, and means for regulating the buoyancy of said frame.

18. In an apparatus as defined in claim 1 wherein said support frame base includes; anchoring means operably connected thereto and being adapted for entering the substratum at said under water source and fixed positioning said frame to said ocean floor.

19. In an apparatus as defined in claim 18 wherein said anchoring means includes; a plurality of anchor piles spaced peripherally about said base, and jacking means operably engaging said respective piles for embedding the same into said substratum.

20. In an apparatus as defined in claim 1 wherein said flexible canopy includes; a plurality of cylindrical sections having a connecting rigidizing ring at opposed open ends thereof, said respective rings being adapted to be operably connected whereby to form a continuous passage through said sections.

21. In an apparatus as defined in claim 4 wherein said float collar includes; conduit means having an intake pipe extending into said float center opening, and having an outlet disposed externally thereof, and means on said outlet for engaging a conduit for conducting fluid from said pool.

22. In an apparatus as defined in claim 4 wherein said float collar includes; means to removably attach a gas accumulator chamber thereto, for receiving gas passing upwardly through said canopy, and for directing the same into a flow line.

23. Method for provisionally directing a flow of fluids escaping uncontrollably from an under water source, which method comprises the steps of; positioning one end of a collapsible cylindrical canopy in the vicinity of said under water source, said canopy when in collapsed condition forming a through passage having an inlet disposed to receive said fluid flow, and an outlet opening, longitudinally expanding at least a part of said collapsed canopy upwardly from said under water source to elongate said passage whereby said outlet opening is at the water's surface, and forming a confined pool of said escaping fluids.

References Cited

UNITED STATES PATENTS
1,017,486 2/1912 Williamson ------------ 61—69
2,536,320 1/1951 Smith ------------ 61—5X
3,389,559 6/1968 Logan ------------ 61—1
3,469,402 9/1969 Lowd ------------ 61—6X

FOREIGN PATENTS
26,576 12/1904 Great Britain 61—82

J. KARL BELL, Primary Examiner

U.S. Cl. X.R.

61—1, 46, 82