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Behar et al.

[11] **3,911,688**

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[54] **PIPE APPARATUS FOR THE COLLECTION OF PETROLEUM FROM DEEP WATER WELLS**

[75] Inventors: **Isaac Behar**, Paris; **Maurice Génini**, Creteil, both of France

[73] Assignee: **Coflexip**, Rueil-Malmaison, France

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[30] **Foreign Application Priority Data**

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[52] **U.S. Cl.** ..... **61/72.3**; 61/46; 61/69; 9/8; 114/.5 F; 141/279; 166/.5; 166/.6

[51] **Int. Cl.**[2] **F16L 1/00**; B63B 35/00

[58] **Field of Search** ..... 61/72.1, 72.3, 46; 166/.6, 166/.5; 141/279, 387, 388; 138/111, 112, 113; 114/.5 F, .5 D; 9/8 P

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Primary Examiner—Jacob Shapiro

Attorney, Agent, or Firm—Brisebois & Kruger

[57] **ABSTRACT**

Piping apparatus for the collection of petroleum from deep water wells which comprises two sets of pipes. A lower set is connected to the seabed wellhead and extends upwards under tension therefrom to a level lying below the zone of surface waves. An upper set is connected to this set and comprises independent flexible tubes which connect the upper end of the lower pipes to delivery points on the surface.

7 Claims, 4 Drawing Figures

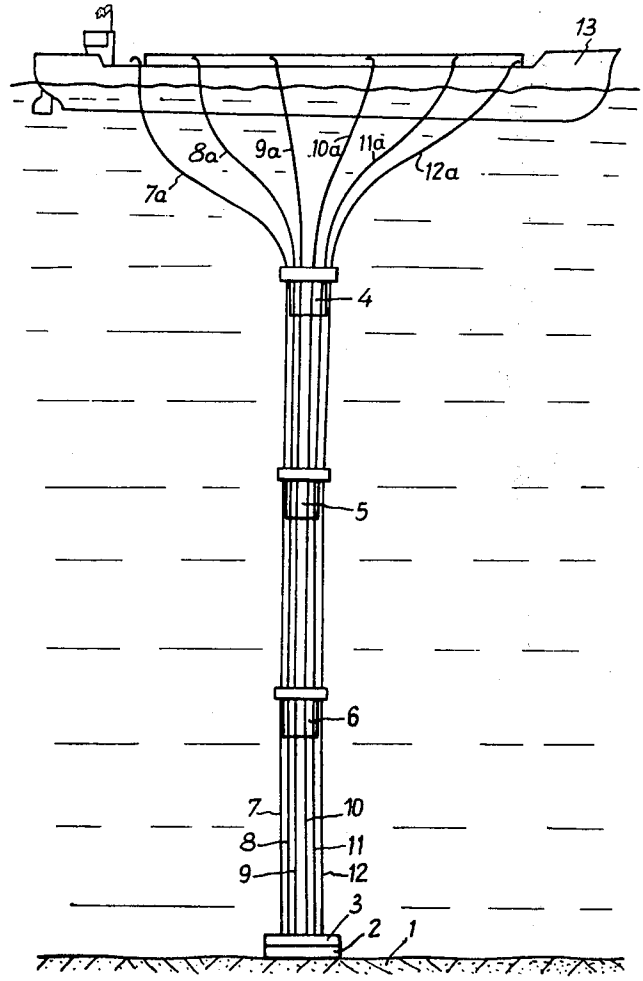


Fig:1

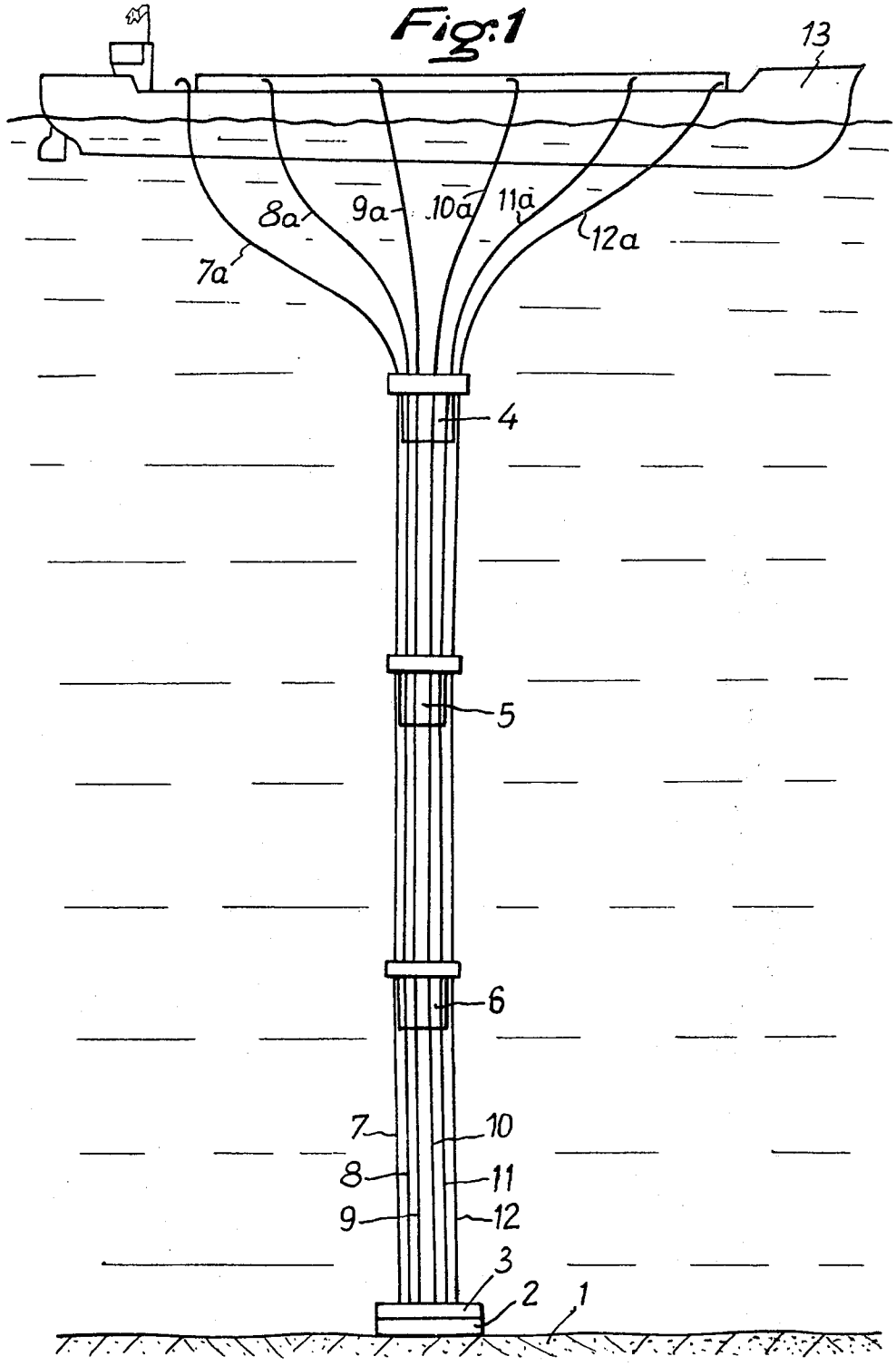
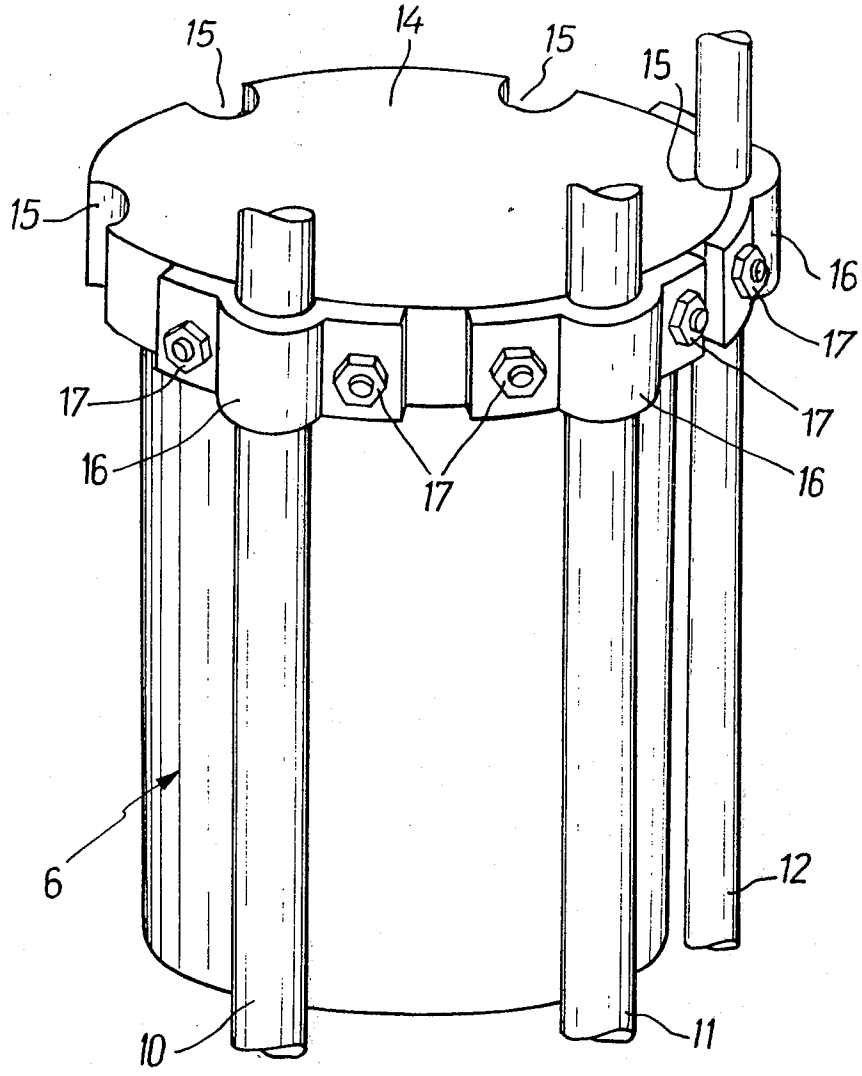


Fig. 2



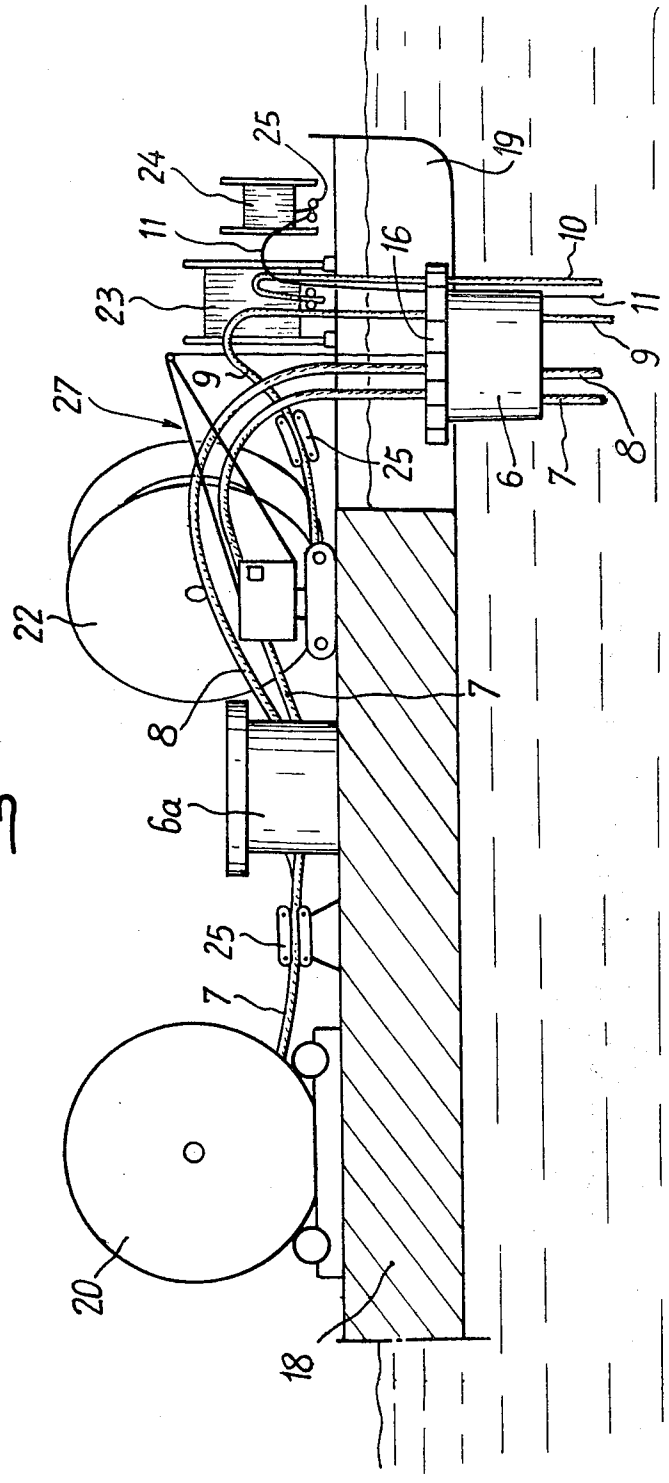


Fig. 3

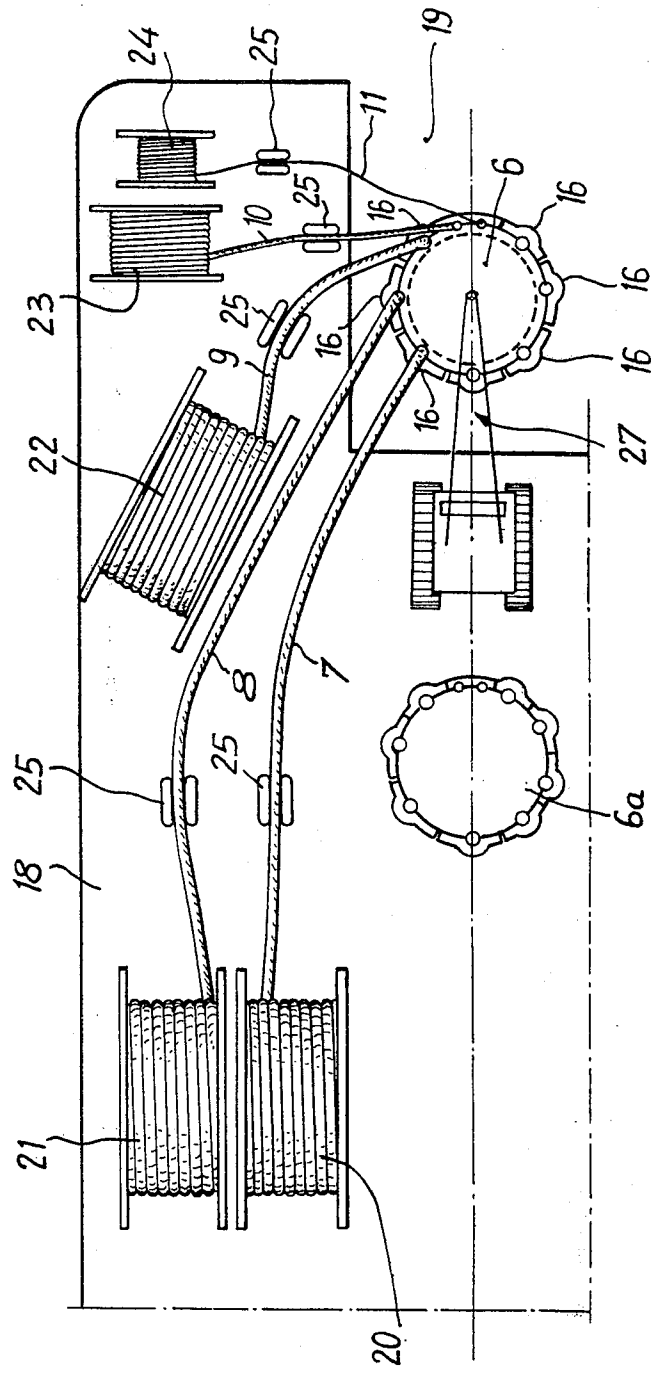


Fig. 4

PIPE APPARATUS FOR THE COLLECTION OF PETROLEUM FROM DEEP WATER WELLS

The present invention relates to a new pipe system for the collection of petroleum from wells situated in deep waters and to a process for setting up such a pipe system.

It is known that it is now necessary to drill petroleum wells in the sea at greater and greater depths.

These wells are in fact situated at depths of several tens of metres, but the exploitation is already envisaged of petroleum deposits at depths of several hundreds of meters, for example 500 meters and more.

Amongst the numerous problems which arise from the exploitation of such wells at great depths, notably it is necessary to provide for pipe systems which have the easiest possible setting up and which enables the large quantities of petroleum produced by the wells to be brought safely to the surface of the water.

The present invention relates to a new type of pipe system for transporting petroleum between the well head situated on the sea bed, for example at a depth of 500 meters, and the surface of the sea, where it has to undergo initial treatment and storage so that it may be transported to the refineries.

To resolve the problem raised by such a pipe system, the invention requires, in part and preferably wholly, flexible tubes of known kind.

Such flexible tubes are generally constituted by a steel sheath which ensures mechanical strength while allowing deformation, and at least one sealing sheath.

The present invention has for its object the novel industrial product consisting of a pipe system for the collection of petroleum issuing from wells in deep water, characterised in that it comprises a lower length of pipe which is situated between the zone of the well head and a level lying below the zone of the surface waves, and which is partly and preferably wholly constituted by a bundle of flexible tubes maintained under tension in positions separated from one another by at least one float situated at the upper part of this length of pipe and preferably by several other floats distributed along the weight of the length of pipe and an upper length of pipe joining up with the upper part of the lower length of pipe, constituted by independent flexible tubes, which bind the upper ends of the flexible tubes constituting the bundles to different points, on the surface of the water, to which the petroleum is to be delivered.

According to the invention the floats used to produce the bundles of flexible tubes should have sufficient buoyancy to ensure tension in the flexible tubes, which are thus kept in a vertical position.

According to the invention, it is also possible to place, in the bundles of flexible tubes, flexible systems of another kind, e.g., systems for carrying electricity or compressed fluid, for example for controlling mechanisims in the well head or in the well itself.

The lower end of the pipe system is provided with a connector, for example of known type, which may be automatically coupled with a corresponding connector fixed to the well head. Different tubes or bundles of flexible tubes are brought into this connector.

The flexible pipes or pipe systems may be advantageously fixed to the floats by collars or like attachment means.

The flexible pipes or pipe systems are each provided with a coupling connector at the end thereof which is situated at the level of the float above the bundle.

In a preferred method of carrying out the invention, the bundle of tubes or the pipe systems is made by placing the pipes or pipe systems on the periphery of the floats, which have a circular or polygonal cross-section, such that the flexible pipes or systems are disposed along the generators of a cylinder.

This arrangement has the advantage of allowing relatively simple fixing of the flexible pipes or pipe system to the floats. It also has the advantage of offering reduced resistance to sea currents which may occur at depth.

To make the upper end of the pipe system, flexible pipes or systems are used which are totally independent one from the other, one end of each of the pipes or pipe system being secured by connectors to the upper end of the pipe or pipe system corresponding to the bundle, and the other end being connected to a connecting point, situated for example in a boat.

The connection of upper and lower pipes and/or pipe systems made equally be carried out across the upper float.

To reduce the wear of the independent flexible pipes constituting the upper lengths, it is desirable so to arrange them that they will not strike against each other by reason of the wave movement.

According to the invention it is also desirable to make the flexible pipes and pipe systems constituting the upper pipe section in such a way that they have of themselves sufficient buoyancy to enable them to come spontaneously to the surface and there to spread out horizontally up to the terminal point.

The float for connecting independent flexible pipes on the lower bundle may be situated at a depth of about 20–60 M.

This depth does not constitute a particular characteristic of the invention.

It is simply desirable that this connection point has a depth sufficiently great to eliminate the effect of the surface swell but sufficiently small to allow a connection which is easy with the aid of divers.

Even for petroleum wells which are situated at bottoms deeper than 500 meters, e.g. at 1000 meters and over, it is possible to make the lower bundle with flexible pipes or pipe systems made in a single length. Connections along the length of the bundle are thus avoided.

Evidently, without departing from the essence of the invention, the flexible pipes or pipe systems of the lower bundle may be made by butting together pipes or pipe system e.g. with conventional connectors.

The floats which assure the maintenance in a vertical position of the bundle which constitutes the lower length of the pipe system according to the invention, are for example distributed every 50 meters of height, without this figure constituting a necessary value.

The float may have a buoyancy sufficient to put under tension by upward traction the sections of flexible pipes and pipe systems which they support.

To facilitate a setting up process which will be explained hereinafter, it is preferable that the floats should be ballasted so that they can be immersed, and, if required, have adjustable buoyancy.

In a variation, it is also possible, without departing from the scope of the invention, to make a part (e.g.,

the lower part) of the length which has just been described, from a rigid steel pipe connected to the flexible bundle according to the invention.

The present invention has equally as an object a process for setting up the pipe system which has just been described. This process being essentially characterized by the fact that with the aid of a barge, situated over the well, the connector with the well head is immersed after having brought under the control of the connector the ends of the flexible pipes which are to form the bundle, the said flexible pipes being rolled up on reels situated as convenient on the barge and each passing in to a traction and retention device which may be constituted by caterpillar tracks and which allows control of their displacements, that the lower connector is immersed and advanced at the same speed as the flexible pipes; that at the height corresponding to the position of the first float, the flexible pipes are brought under control of the first float which is thereafter immersed; that this operation is repeated with successive floats up to the immersion of a float of the upper part of the bundle which comprises the connectors for the flexible pipes of the upper length ; that this bundle thus obtained is immersed while proceeding with the automatic coupling of the connector disposed on the lower part of the bunle with the base comprising the well head; and that the connecting of the lower ends of the flexible pipes constituting the upper length with the connectors of the upper float is proceeded with, as well as the connection of the upper ends of the flexible pipes of the upper lengths to different points on the boat where the petroleum is to be discharged and, if required, treated.

It can be seen that the process just described permits the setting up of the flexible vertical bundle in a simple and efficacious manner. During the descent of the flexible pipes, it is fitting to give the different floats a negative buoyancy so as to tension the bundle vertically downward.

On the contrary, when the lower part of the bundle is fixed on the wellhead, it is advisable to modify the ballasts of the floats to give them a positive buoyancy which ensures a vertically upward traction on the different flexible pipes.

Fixing of the flexible pipes to the different floats can be effected by any appropriate means, for example with the aid of half-collars which engage on corresponding half-collars integral with the float and placed at its periphery.

It can be seen that by the process according to the invention, the constriction of the bundle of flexible pipes which is to be immersed to a great depth is entirely effected from the barge which supports the installation.

The connection to the base which comprises the wellhead is effected automatically, using for example a known device.

Finally, taking account of the fact that the upper part of the bundle is situated at a depth of several tens of meters, it is very easy to proceed with the connection of the flexible pipes of the upper length of pipe with the help of submarine divers.

In this manner it is possible easily to monitor and if necessary to replace flexible pipes situated in the zone of the swell, which are on these grounds subjected to stresses and wear which are much greater than those affecting the flexible pipes in the lower length of pipe.

For better understanding of the invention there will be described, by way of an illustration and without limitation of any kind, an embodiment taken as an example and shown in the drawing.

In this drawing:

FIG. **1** shows a schematic elevation view of the pipe system according to the invention,

FIG. **2** is a schematic perspective view showing how different flexible pipes are connected to a float to form the bundle, and

FIGS. **3** and **4** are elevation and plan views of a barge which sets up the bundle of flexible pipes according to the invention.

The structure of the pipe system according to the invention has been shown very schematically in FIG. **1.**

At the lower part of this FIGURE, the seabed **1** can be seen, together with base **2** comprising the wellhead.

The lower part of the bundle is furnished with a counter-base **3** for automatic coupling to the base **2.**

The lower length of piping of the pipe system according to the embodiment shown is constituted by a bundle of flexible pipes which extends between the base **2** and the upper float **4.**

It will be noted that the embodiment shown in the drawing comprises two intermediate floats **5** and **6,** whose structure can be analogous to that of the float **4.**

Likewise the flexible pipes **7,8,9,10, 11** and **12** have been shown schematically, and it is clear that there may be any number of them whatever.

Ship **13,** which is connected to the upper part of the bundle of flexible pipes by independent flexible pipes *7a*,*8a*,*9a*,*10a*, *11a*, and **12***a*, can be seen in the upper part of FIG. **1.**

The upper ends of these flexible pipes are connected to suitable points of the ship **13,** whilst the lower ends are connected to the corresponding ends of the flexible pipes **7,8,9,10,11,** and **12,** or to the float **4** in the case where the connections are made through the upper float.

The float **4** can for example be immersed at a depth of some tens of meters.

In the embodiment shown, only two intermediate floats are shown, but of course their number may be greater. A float can, for example, be placed at every 50 meters.

An embodiment of the floats and the fixing of the flexible pipes to the floats is shown schematically in FIG. **2.**

The float **6** has the form of a cylindrical volume with a vertical axis and furnished with a plate **14** at its upper part. The periphery of the plate **14** is furnished with semicircular recesses **15** to receive the flexible pipes.

The flexible pipes such as **10,11** and **12** are held in the recesses of the plate **14** by half-collars **16** fixed to the plate by bolts **17.**

In the embodiment which has just been described, the flexible pipes are brought into the upper part of the float, but of course this disposition is in no way obligatory and the flexible pipes could be fixed likewise to the middle or to the lower part of the float. In other respects, the flexible pipes could be fixed to the floats by any appropriate means.

In FIGS. **3** and **4,** it is schematically shown how it is possible to fix the bundle with the aid of a barge **18** of which one end has been shown in longitudinal section in FIG. **3** and in partial plan view in FIG. **4.**

The barge **18** comprises at its end or at its middle a cut-out part or well **19,** to enable the flexible pipes to be immersed.

The different tubes or flexible pipings which are to constitute the bundle are wound on reels **20,21,22, 23** and **24,** as can be seen in FIGS. **3** and **4.**

The other side of the barge, not shown in FIG. **4** , of course likewise comprises analogous reels.

Likewise there can be seen in FIGS. **3** and **4** the flexible pipes **7,8,9** and **10** which unwind from the reels and which each pass over a drive device with caterpillar tracks **25** enabling their progress to be controlled.

The float **6** and also the half-collars **16** which enable the flexible pipes to be fixed on the float have been shown schematically in FIGS. **3** and **4.**

In the position shown in FIgS. **3** and **4,** the float **6** is supported by a crane **27** which enables the different floats to be displaced and introduced into the well when they are to be secured to the flexible pipes.

Particularly, there will be seen on top of the barge a second float **6***a*, which is waiting.

It can be seen that by means of the device which has just been described, it is easy to carry out the immersion of the bundle.

For this, the lower connection **3** is first placed in the well **19,** supporting it by means of the crane **27.**

To the connection **3** are secured the ends of the different flexible pipes **7,8,9,10, 11,** etc., then the connection is progressively immersed while the caterpillar tracks **25** ensure the controlled displacement of the flexible pipes.

When the depth of immersion is reached which corresponds to the position of the first float, the part of the bundle which is immersed is supported, while locking the flexible pipes with the aid of an appropriate device, by means of the crane **27,** and the float is brought into the position it should occupy. The flexible pipes are then secured to the float (by means of the collars **16** or another appropriate means) and the operation is repeated until the completion of construction of the bundle.

When the bundle is thus obtained, it is fitting to connect it to the wellhead.

For this, it is necessary to lower it by the depth which corresponds to the depth of immersion of the float **4.** This lowering should be effected preferably by means of an anti-pounding device to prevent the effects of the swell having repercussions on the lower end of the bundle. The connection of the base **2** and the counter-base **3** is effected automatically by means of a known type of device, for example.

The connection of the independent upper flexible pipes is effected by conventional means with the aid of undersea divers.

The pipe system according to the invention has the advantage of particularly simple placement which can be effected from a conventional barge.

It likewise has the advantage of separating, in a distinct manner, the zone of the vertical bundle at a great depth and the zone at shallow depth where the flexible pipes can easily be monitored, repaired and changed.

The fact that the vertical bundle is constituted by flexible pipings enables transverse currents to be withstood more easily, even if these currents are oriented in different directions at different depths.

In a variation, the lower part of the pipe system can be constructed in part from at least one rigid tube and in part from a bundle of tubes or flexible pipings such as has been described.

It is always to be understood that the embodiment which has been been described above has no limiting character of any kind and that it can undergo any desirable modifications without departing from the scope of the invention on this account.

We claim:

1. Piping apparatus for the collection of oil derived from a wellhead in deep water comprising:

a float immersed in said water below the zone affected by the surface swell,

a lower first bundle of flexible tubes located between said float and the wellhead, said tubes being maintained in tension by said float in positions spaced one from the other,

an upper second bundle of flexible tubes located between said float and the surface of the water, each of the tubes of said second bundle being connected to a tube of said first bundle, and means maintaining the upper end of said upper bundle of tubes near the water surface.

2. Piping apparatus according to claim **1** in which said first bundle further comprises additional floats distributed along its length.

3. Piping apparatus according to claim **2** in which the floats have a buoyancy sufficient to exert a vertical upward traction on the tubes of the first bundle after the latter has been fixed to the wellhead.

4. Piping apparatus according to claim **3** in which the floats are provided with ballasting means capable of imparting an adjustable buoyancy to said floats.

5. Piping apparatus according to claim **2,** in which the flexible tubes are disposed at the periphery of the floats.

6. Piping apparatus according to claim **1,** in which the flexible tubes of the upper bundle have sufficient buoyancy along their length to tend to ascend to the surface of the water.

7. Method of installing in deep water piping apparatus for the collection of oil derived from a wellhead in deep water comprising:

a float adapted to be immersed in said water below the zone affected by the surface swell,

a lower first bundle of flexible tubes located between said float and the wellhead, and

an upper second bundle of flexible tubes adapted to be located between said float and the surface of the water, each of the tubes of said second bundle being connected to a tube of siad first bundle, and carried by a boat in which said tubes are wound on reels, which method comprises the steps of

1. attaching said lower bundle of tubes to means for connecting said lower bundle to a wellhead,
2. lowering said connecting means from said boat by unwinding said lower bundle of tubes from said reels until a length of tubing has been unwound which is equal to the distance at which a first float is to float above said ocean floor,
3. attaching said float to said lower bundle of tubes,
4. repeating said second and third steps as necessary until the upper end of the lower bundle has been immersed below the zone affected by surface swells, and the lower end of said lower bundle reaches said wellhead,

5. attaching the lower end of said lower bundle to said wellhead with said lower bundle under tension between said wellhead and float,

6. connecting the lower end of the upper bundle to the upper end of the lower bundle and the upper end of the upper bundle to fluid receiving means at the surface of the ocean.

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