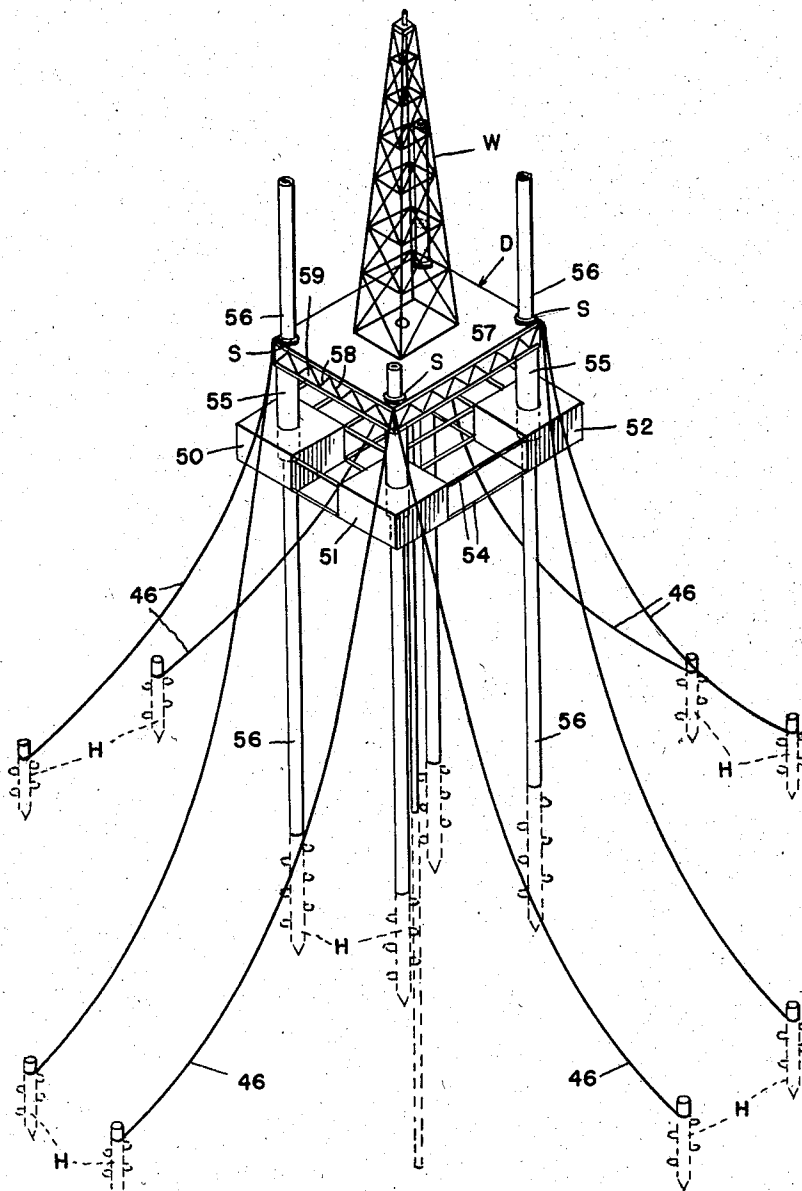


Filed March 12, 1956

MUD ANCHOR

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FIG. 1



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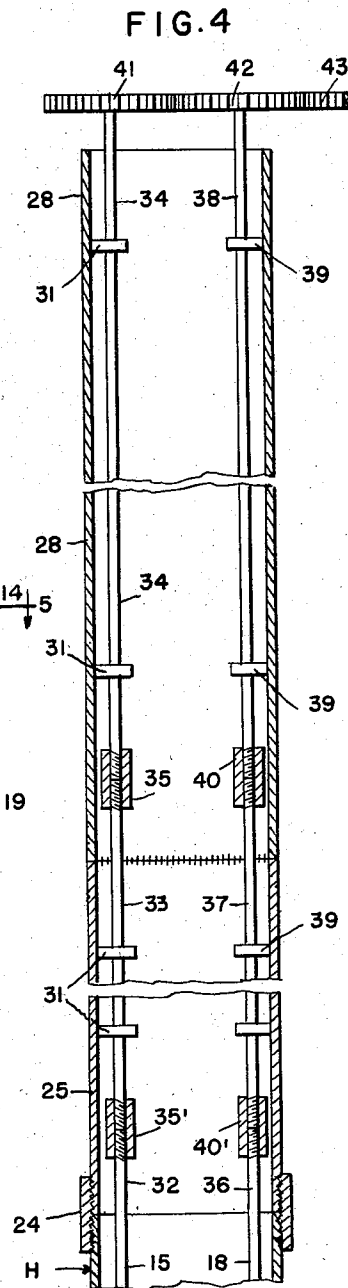
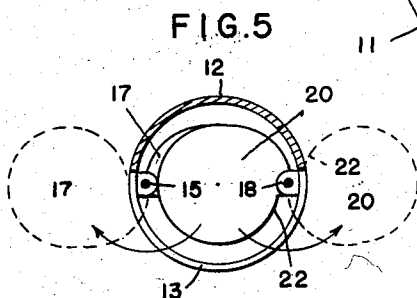
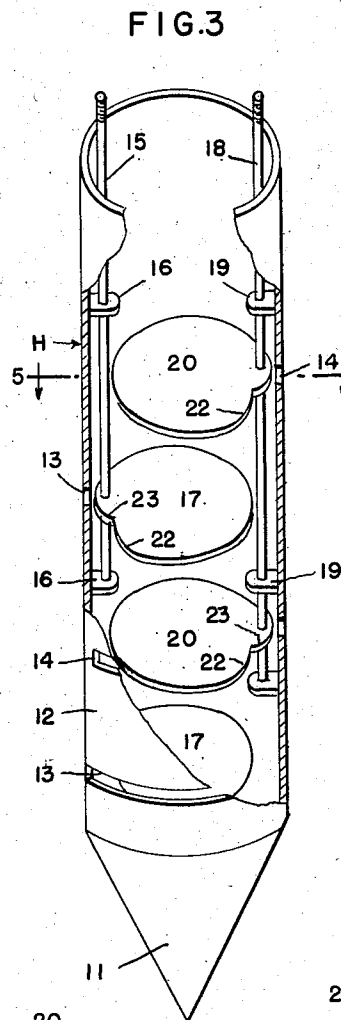
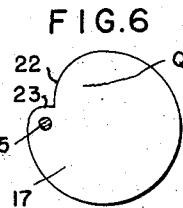
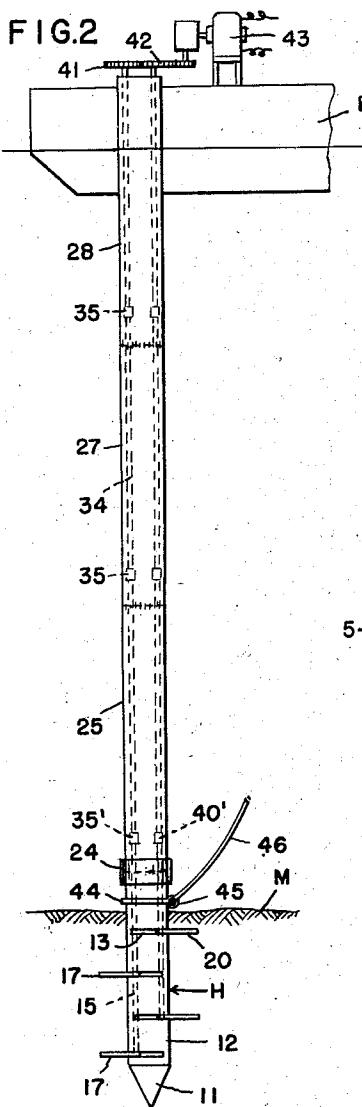
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4 Sheets-Sheet 2



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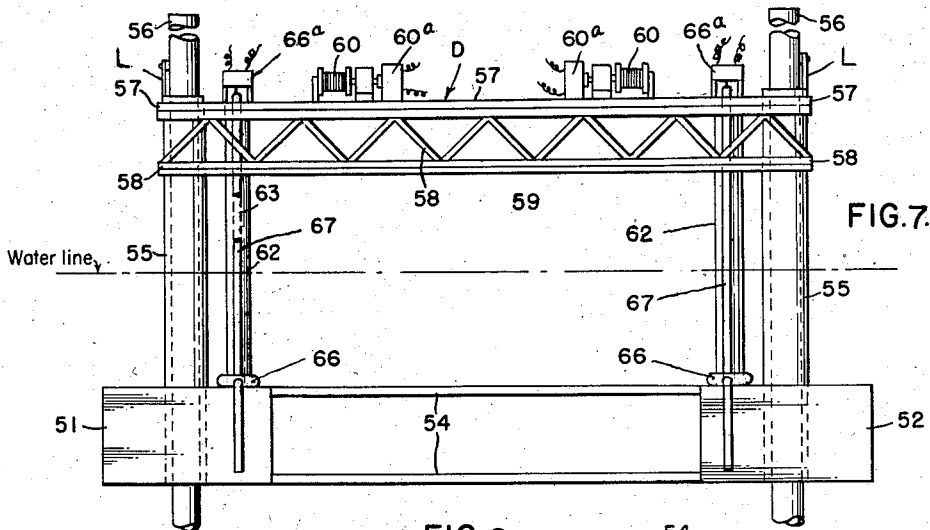


FIG. 7.

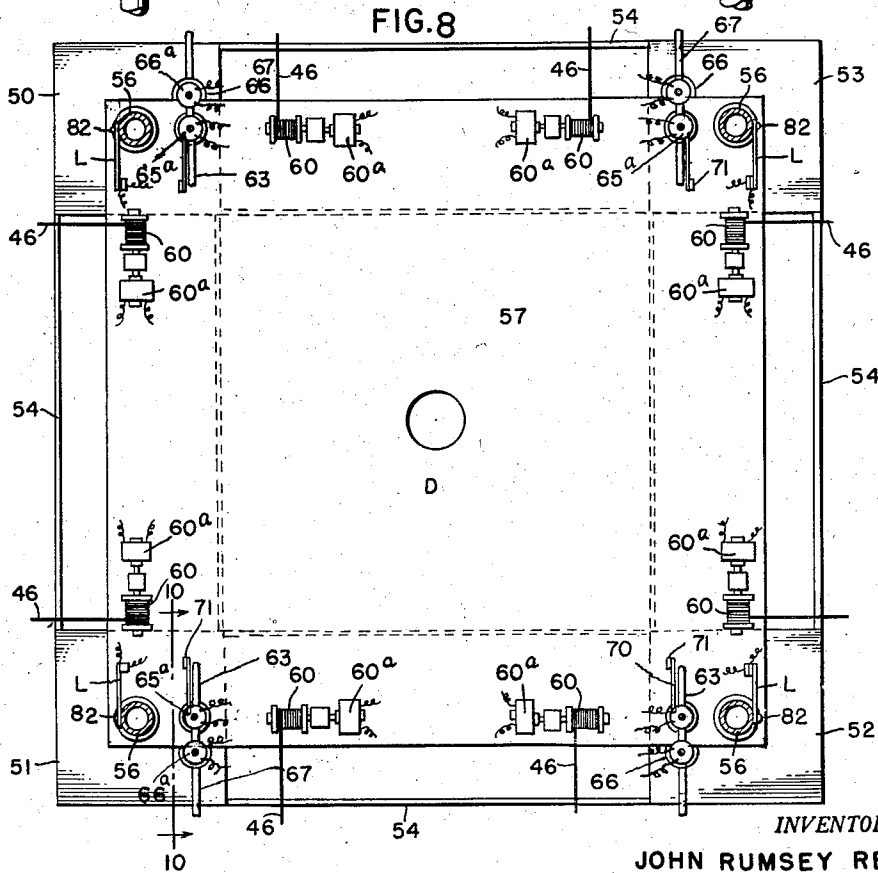


FIG. 8

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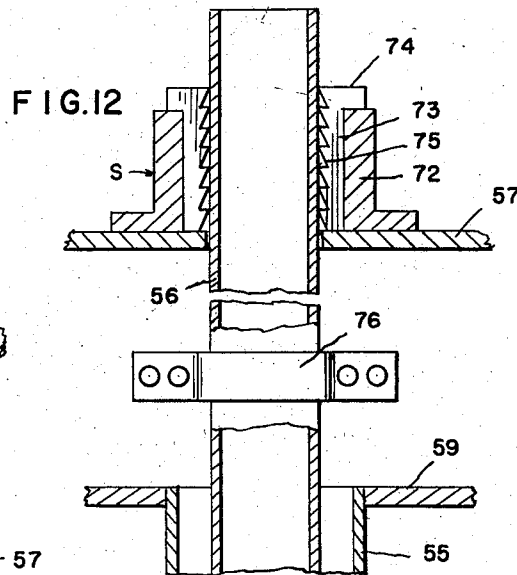
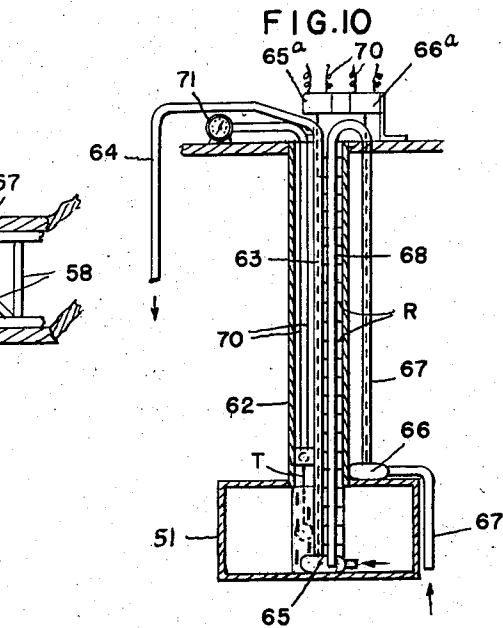
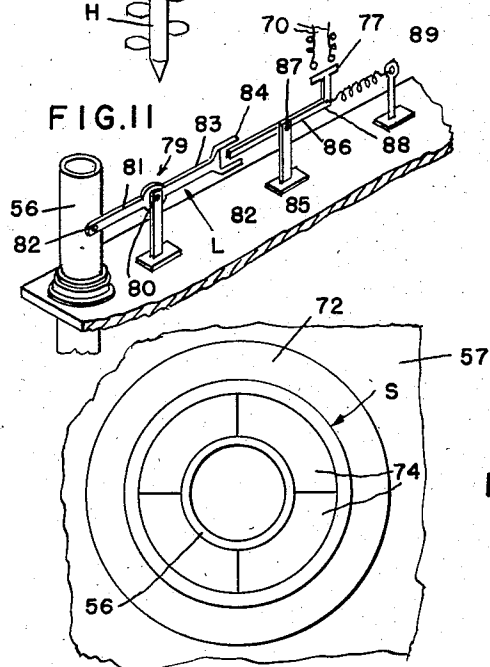
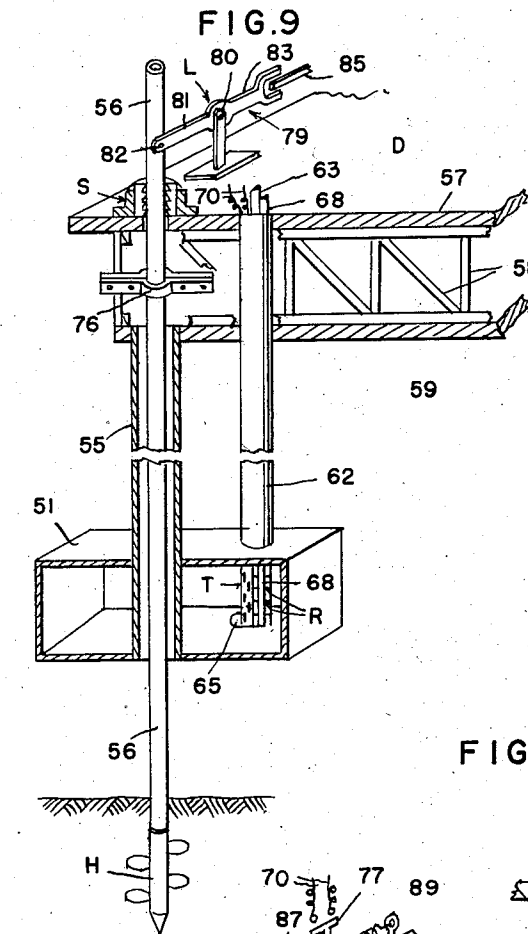


FIG. 13

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MUD ANCHOR

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Application March 12, 1956, Serial No. 570,850

2 Claims. (Cl. 61—46.5)

This invention relates to mud anchors and floating foundations for use in offshore drilling. Drilling for oil, gas, or sulphur in the water of the outer continental shelf is limited by the depth of the water. Platforms built on piling for drilling wells, or barges raised on caissons or piling are extremely difficult and expensive to construct and maintain in water more than 75 to 100 feet deep because the soft mud of the sea bottom is not stable enough to support the heavy structures by the use of ordinary piling. So it is an object of this invention to devise a special type of floating structure from which drilling can be carried out and yet which structure while floating is stabilized on piling that is anchored. More particularly, this invention proposes a catenarily anchored deck for supporting the drilling equipment which deck has an open cylinder fixedly depending from each corner portion thereof and an enclosed entirely submerged deck-supporting float for each cylinder vertically through which float the cylinder fixedly rises to and through the deck, while piling rises through each cylinder from the sea bottom. The floats are submerged so as not to be affected by surface wave action and the deck is supported therefrom, so it is a further object of this invention to devise ways and means for stabilizing the elevation of the floating deck with respect to the piling that rises upwardly from the sea bottom, and another object is to associate the floating but anchored deck with the fixed piling rising through its corners, under conditions whereby the piling is maintained under tension rather than compression, while a further object is to devise means for regulating that tension. Yet another object of the invention is to devise means whereby the deck is automatically restored to its normal position if and when the deck tends to settle. A further object is to provide stop means for limiting further settling of the deck in the event that the automatic means for some reason does not actually restore the settling deck to its norm.

In order to accomplish the foregoing objects, the deck while floating must be anchored, so it is an object of this invention to devise a new and effective mud anchor that is useful not only for this deck, and for its pilings, but is also useful in supporting or anchoring various types of marine structures.

These, and possibly other, objects can be realized by a floating but anchored deck having an open cylinder fixedly depending from each corner portion thereof, an enclosed entirely submerged deck-supporting float for each cylinder vertically through which float the cylinder fixedly rises to and through the deck while the floats are secured in horizontally-spaced relationship with anchored piling rising through each cylinder from the sea bottom. The deck is catenarily anchored and has means for controlling the depth of submergence of each float as well as means for applying regulated tension on each piling. This last sentence described in broad language points to features of novelty of this invention but many of such features are also included in the construction and arrangement of each of the three means mentioned, including

2

also the details of the mud anchor together with the manner of its emplacement, as shown and described herein.

The invention is illustrated in the accompanying drawings in which Fig. 1 is an isometric showing of the floating structure anchored in place with anchor heads of this invention. The scale of the floating deck is so small that the equipment provided thereon, as shown in Figs. 7 and 8, is not indicated thereon. Fig. 2 is a vertical elevation of an anchor head with the pipe extension by the use of which the anchor is emplaced. Fig. 3 is an isometric view with parts in section of the anchor head. Fig. 4 is a vertical sectional view through a portion of the pipe extension shown in Fig. 2. Fig. 5 shows a transverse view looking down on the anchor head, taken along the line 5—5 in Fig. 3. Fig. 6 is a plan view of one of the blades or discs of the anchor head. Fig. 7 is a side elevational view of the floating structure except for its derrick or rig W, while Fig. 8 is a plan view thereof. Fig. 9 is a partial isometric view with parts in section of one of the floats 51 and its connections. Fig. 10 is a vertical sectional view through one of the service tubes 62, and its connections. Fig. 11 is a partial isometric view of the lever-operated switch mechanism L. Fig. 12 is a vertical sectional view through a piling and one of the casing rings and slip S.

Since the floating platform or deck of this invention as well as the piling thereof must be anchored, there will be described first a form of anchor head that I prefer to use, although it is not indispensable to the invention, and indeed, it has other uses without being associated with embodiments of the floating deck invention. So the head H has a pointed end 11 carried by a tubular body 12, provided with a set or plurality of superposed peripheral slots alternately numbered 13 and 14 whose extent is approximately a semicircumference, and which are aligned parallelly. Extending longitudinally and internally of the tubular body 12 adjacent one end of the slots 13, is a shaft 15 rockably held in lugs 16 extending inwardly from the periphery of the tubular body 12, and secured to this shaft to rock therewith, are a set or plurality of discs or blades 17, with each disc aligned with one of the slots 13, so that as the shaft 15 is rockably rotated, its discs each swing as a group through a slot 13 with which it is aligned whereby the discs 17 then extend laterally from one side of the tubular body 12, as shown in Figs. 2 and 5. In the tubular body there is another rockable shaft 18, similar in all respects to shaft 15, except located at 180° therefrom, rockably supported in lugs 19, and having secured to the shaft, another set of discs or blades 20, aligned with slots 14, whereby they can swingingly pass through those slots to extend laterally from the tubular body 12, but on a different axis than do the discs 17 and in a different direction therefrom. These discs are all similarly shaped and are generally circular in plan view but as can be seen in Fig. 6, wherein approximately three-quarters of the disc is circular, but its fourth quarter Q has its periphery given a sharper curvature or tumblehome at 22 to provide a shoulder 23 adjacent the rockable shaft 15 from which the disc is supported. If the discs were fully circular, in order to get them to swing through their associated slots, the slots would have to extend through more than one-half the circumference of the tubular body (because otherwise the discs would be stopped by the limitation of the slots) and this would weaken that body too much, so by providing the tumblehome 22, and the shoulder 23, a shorter slot thus can be used. For the purpose of emplacing the mud anchor of anchoring head H, it can have threaded to its free end, a coupling 24 screwed thereon to which also is connected such as by welding other lengths of pipe 25, 26, 27, and so on, until a terminal section of pipe 28 reaches to an elevation above the

3

water-level up to a barge 29 or other float from which workmen can operate. In this extending piping there rises through lugs 31 extensions such as 32, 33 and 34, of rockable shaft 15 in the tubular head 12, and these are coupled together by couplings such as 35, but the bottom coupling 35' is splined so that the shaft extension can be uncoupled thereat. In the same manner, rockable shaft 18 in the tubular head 12, has shaft extensions 36, 37 and 38, rotatable in lugs 39, and having couplings such as 40, but the bottom coupling 40' is splined so that the shaft extensions can be uncoupled thereat. At the top of shaft extensions 34 and 38, at an elevation above the water-level, are meshing gears 41 and 42, that may be motivated by a suitable motor and speed reducer 43 (supported on a barge B), adapted for rotating the shaft extensions 34 and 38, and thus rocking the disc-bearing shafts 15 and 18 in the tubular body of the anchor, to swing the discs or blades 17 and 20 through the slots with which they are aligned to project them into the mud M of the bottom to provide laterally extending anchoring surfaces for resisting pull on the anchor head. As soon as the discs or blades have been so laterally projected by the rocking of the shafts that carry them motivated from the motor temporarily located on the top of piling or other such support, the shaft extensions 34 and 38, with their splined couplings such as 35' and 40' can be removed from shafts 15 and 18 of the tubular anchor head and drawn up to the surface. Thereafter, the pipe extensions such as 25, 27 and 28 with their weldings can be unscrewed from the anchor head and drawn up to the surface, leaving the anchor head emplaced and embedded in the mud of the sea bottom. If the anchor head is to be used as the mud-penetrating head on a pile, the shaft extensions can form that pile, and they would not be withdrawn to the surface. But if the anchor head is to be used as a dead-man to anchor down something else, such as a float, the pipe extensions are so drawn up. But in this case, around the upper end of the tubular anchor head is provided a band 44 with a loop or eye 45 to which can be attached the wire rope or chain 46 leading up to the float.

Now we come to the floating but anchored drill-supporting structure indicated generally by D on which is to be mounted an oil-well drilling rig or other apparatus W that is to deal with the sea bottom. There are four floats 50, 51, 52 and 53 which while shown as substantially rectangular in shape, can be cylindrical or other suitable shape as local circumstances may dictate, but there is a float for each corner of the deck and suitably horizontally spaced apart by tying structure 54. Extending upwardly through each float is a cylinder 55 having a diameter of say 6 feet for providing a hollow passageway upwardly through which can rise the upper portion of a piling 56 from its mud anchor H, or any other suitable anchor. The floating structure D is formed of a main or upper platform or deck 57, reinforced such as by trusses 58 located marginally and otherwise as necessary, and at least a partial lower platform or deck 59. On the upper deck 57 is provided a set of winches 60 driven by motor 60^a to each of which winches is secured wire rope or a chain 46 leading downwardly catenarily to an anchor head H. Coming back to the construction of each float of which float 51 is an example, and its cylinder 55, the latter preferably stops at or just above the elevation of the lower deck 59, and also terminating at about that same height is a service tube 62 of about 4 feet in diameter to serve as a passageway for a man to get down into the float since it will be equipped with ladder rungs R for that purpose. It will also carry a pipe 63 from within the float to a point on upper or main deck 57 for connection with a pump 65 driven by motor 65^a by which water can be pumped out of the float and expelled through pipe continuation 64 back to the sea for relieving the float of some of its water ballast. Another pump 66, driven by motor 66^a is provided exteriorly of the

4

tube 62 and on the floats, for supplying water ballast to the float by pumping water from the sea up pipe 67 and down pipe 68 into the float, should it need more water ballast than it has at the moment. The ballast-adding pump 66 is manually initiated, but the ballast-expelling pump 65 is automatically controlled in a manner hereinafter described, in addition to being manually operable when desired. In each float such as 51 there is a float-operated electrical indicating circuit composed of a small ball float 69 within the main float 51, whose vertical fluctuations will, through rise and fall in an apertured guiding vertical pipe 70 of a perforated tape and supporting the ball float at its lower end and taking around a reel at its upper end, operate an electrical circuit connected to an indicator 71 on the upper deck for indicating the depth of water ballast in the float. The construction and accessories are the same for each float 50, 51, 52 and 53, but only one such set will be described. The perforated tape type of water-level indicator is made by Telematic Corporation of 2937 North Lincoln Avenue, Chicago 13, Illinois.

It has been stated that it is important to have the anchored and floating deck D maintain tension on each of the pilings with which it is associated. One of the means for accomplishing this is the use in each corner of the deck on a piling thereat, of a casing ring and slip indicated generally at S, and shown in more detail in Figs. 12 and 13. It comprises a flanged collar 72 suitably anchored to the deck in a position encircling the piling and axially within the collar are a plurality of arcuate or curved plates 73, each having an outwardly extending flange 74 at the top thereof by which the plate is suspended within the collar 72 in a manner whereby the arcuate plates for a cylindrical lining are held within the collar 72. Each curved plate 73 has a plurality of linearly extending upwardly projecting teeth or ridges 75 adapted to bite into the piling if and when the floating deck tends to rise with respect to the piling, but which teeth or ridges slide freely downwardly along the piling if and when the floating deck tends to fall with respect to the piling. To serve as a limit to the lowermost elevation to which the floating deck may fall with respect to the piling, there is provided a casing clamp 76 secured to each piling at an elevation thereon preferably between the upper and lower decks. If the deck falls far enough to reach that clamp, it will then support that corner of the deck directly from its piling.

The automatically controlled motor-operated pump 65 for expelling water ballast from the floats, such as 51, is controlled by a switch 77 in the motor circuit 70 that is energized when the elevation of a corner of the deck falls with respect to its piling and is de-energized when the elevation of that corner of the deck is restored to its normal position with respect to its piling. Any suitable mechanical movement can be used for thus operating switch 77, but by way of example, there can be a lever 79 fulcrumed at 80 supported from the deck, with its power end 81 pivoted at 82 to a piling while its work end 83 carries a yoke 84, adapted on rocking of the lever 79 to move the power end 85 of another lever 86 fulcrumed at 87, and whose work end 88 engages and operates the switches 77. A spring 89 can be provided to bias the lever 86 against too easy operation. All of this switch operating levered mechanism is indicated generally by the letter L.

As to the operation of embodiments of this invention, since it is first necessary to emplace the anchor heads, that and their functioning will be described initially. Fig. 2 is illustrative of their emplacement from a barge B or other suitable support, from which the anchor head H supported from a length of pipe sections such as 25, 27 and 28, suitably secured together, such as by welding, is descended through the water and forced into the mud M of the sea bottom. The next step is to energize motor 43 on the barge B to rotate meshing gears 42 and 41

5

to rotate through about 180° , shafts 34 and 38, with their extensions respectively, 33 and 37, 32 and 36, and finally 15 and 18 in the anchor head, whereupon the discs 17 on shaft 15 are pivotally moved clockwise out through slots 13 until they take their extended weight-supporting and anchoring position as shown in Fig. 5. Similarly, discs 20 on shaft 18 are pivotally moved counterclockwise out through slots 14 until they take their extended and anchoring position as shown in Fig. 5. By having the slots 13 and 14 all on one side of the tubular body 12 of the anchor head H, it seems to remain stronger than if the slots were on alternate sides. Moreover, the slots can be made of minimum length by shaping the discs the way they are shown to be shaped in Fig. 6, with the tumblehome at 22 on the fourth quarter Q of the periphery terminating in the shoulder 23. If the anchor head is to be used as a dead-man, after the anchor head has been emplaced, the welded-together pipe sections can be unscrewed from the coupling 24 at the top of the anchor head and removed to the surface, leaving the anchor head in place with its band 44 and loop or eye 45 to which is attached wire rope or chain 46. In so disconnecting the anchor head, not only does the pipe section 25 become unscrewed from the coupling 24, but the shaft 32 comes unfastened from coupling 35' and shaft 36 comes unfastened from coupling 40', whereupon the emplaced anchor head is left in a condition as shown in Fig. 3. If the anchor head is not to be used as a dead-man, but left at the end of a piling, of course, these removal steps are not carried out.

In Figs. 1 and 8, the floating structure has been shown to be square in plan view, but of course, it could be made of other shapes, if desired, and the same applies to the floats 50, 51, 52 and 53, one of which surrounds each piling 56. These floats are held together by suitable tying structures 54, and it is to be understood that the floats are adapted to be used in total submergence whereby they are not subject to damage by surface wave action. Rising through each float and encircling a piling is a cylinder 55, from the top of which cylinders is supported the lower platform or deck 59 from which rise trusses 58 to support the upper or main deck 57 of the floating structure D. Rising from the top of each float, as can be seen from Fig. 10, there is a service tube for providing access by man along the ladder rungs R into and out from the interior of the floats. Since it is important to provide means for pumping water from the interior of the float, either to expel water-ballast therefrom, or to expel water leaking therein, such a submerged pump 65 is fitted in the float while operated by motor 65^a on deck 57, and a pipe 64 conducts the water back to the seal. Water-ballast can be provided for the float by means of pump 66 located exteriorly of the float but in submergence, while operated by motor 66^a on the deck 57, and pipe 68 conducts water from the sea into the float. The service tube also contains an apertured vertical pipe 70, in which is supported a floating ball at its lower end by means of a perforated tape T. The ball is adapted to rise and fall with the heights of water in the main float and as it rises and falls, the tape taking around a reel, rotates the reel to indicate on the indicator 71 on deck 57, the depth of the water in that particular float.

The floating structure, which is anchored in place by the catenary wire ropes or chains 46, secured to the anchor heads H, is floating-supported from the floats 50, 51, 52 and 53, but the floating structure is secured in place over a predetermined spot on the sea bottom by means of the pilings each rising through the cylinders 55 on the floats. These pilings are fixedly attached to anchor heads identical to the anchor heads discussed in the second preceding paragraph. But it is always possible that the deck D may not remain level, since one corner thereof may settle more than another due to more or less water being in the float that supports that particular corner. So this invention provides automatic means for expelling ballast water from a float in the event that the

6

corner of the deck it supports tends to settle or become depressed.

However, before describing those means, it should be understood that surrounding each piling 56, and supported from the deck 57, is a casing ring and slip S (Figures 9, 12 and 13) whose function is to put tension on the piling if and when the deck tends to rise with respect to the piling, due to the teeth 75 (on the segments 74 held in the collar 72) biting into the piling when the deck rises, although permitting substantially free fall of the deck. If and when the deck settles, the casing clamp 76 secured to the piling, serves as a limit to the distance the deck can descend when the upper deck 57 falls enough to engage that clamp (see Figs. 9 and 12).

Referring again to the means for expelling ballast water from the floats, the ballast-expelling pump 65 for each float has its motor 65^a in circuit 78 with a switch 77 (Fig. 11) that energizes the motor when that corner of the deck falls, and de-energizes the motor when that corner rises. This is accomplished, for example, by the arrangement in that figure, comprising the lever 79 whose power arm 81 is pivoted at 82 to the piling and whose work arm 83 operates a second lever 86 that in turn either closes or opens the circuit 78 with its switch 77, remembering, however, that meanwhile, if the corner settles, the extent of such settling is limited by the casing clamp 76.

Irrespective of the automatic lever-controlled pump operating means for expelling ballast water from a float, means are provided for the manual operation of that pump to remove water from the float, in the event that the indicator 71 on the deck shows that the water in the float has reached too great a depth (or height). The ballast-supplying pump motor 66^a is manually controlled.

The mud anchor design is capable of other uses than in combination with the floating structure shown herein, especially in such situations wherein would be advantageous the functioning of the pivoted discs 17 and 20 which, when extended, increase the weight-supporting capacity of the mud anchors.

As this invention may be embodied in several forms without departing from the spirit or essential characteristics thereof, the present embodiment is therefore illustrative and not restrictive, since the scope of the invention is defined by the appended claims and all changes that fall within the metes and bounds of the claims or that form their functional as well as conjointly co-operative equivalents, are therefore intended to be embraced by those claims.

I claim:

1. A mud anchor comprising a hollow tubular shaft open at one end and having a mud penetrating portion at its opposite end, said shaft having a plurality of vertically spaced transverse slots, each slot being of a width greater than substantially more than one half the circumference of said tubular shaft, a plurality of substantially circular flat metallic plates horizontally and pivotally mounted in staggered relationship within the tubular shaft in substantial alignment with said transverse slots, actuating means for said plates including a plurality of vertically extending rotatable rods mounted within said tubular shaft and extending through said circular plates and affixed thereto, said plates being eccentrically mounted thereon such that on rotation of the rods said plates will be extended outwardly or retracted, support means for said rods secured to the interior wall of said tubular shaft at spaced points therein and through which said rods extend, and means affixed to the terminal ends of said rods for imparting rotation to said rods to extend or retract said flat plates outwardly from said tubular shaft through said transverse slots into engagement with the surrounding mud or inwardly into the surrounding

tubular shaft to allow the said tubular shaft to be recovered from the surrounding mud.

2. A mud anchor as defined in and by claim 1 wherein the diameter of said flat metallic plates is substantially less than the full inside diameter of the tubular shaft so as to be housed therein and when extended into engagement with the surrounding mud present a large bearing area to prevent the anchor from being easily displaced.

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