May 17, 1960 C. H. THAYER 2,937,006

UNDERWATER DRILLING RIG

Filed May 17, 1957 4 Sheets-Sheet 1

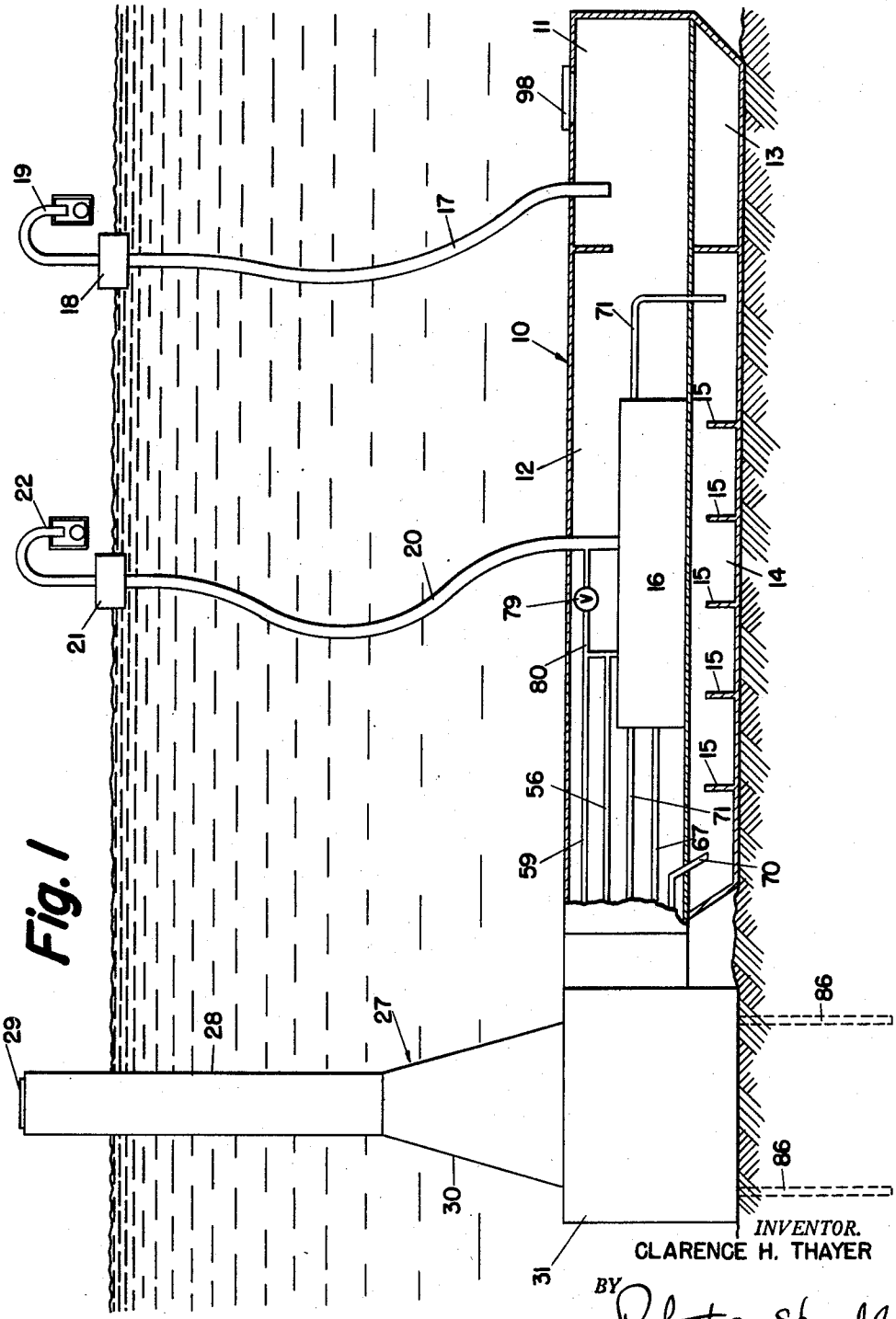

Fig. 1

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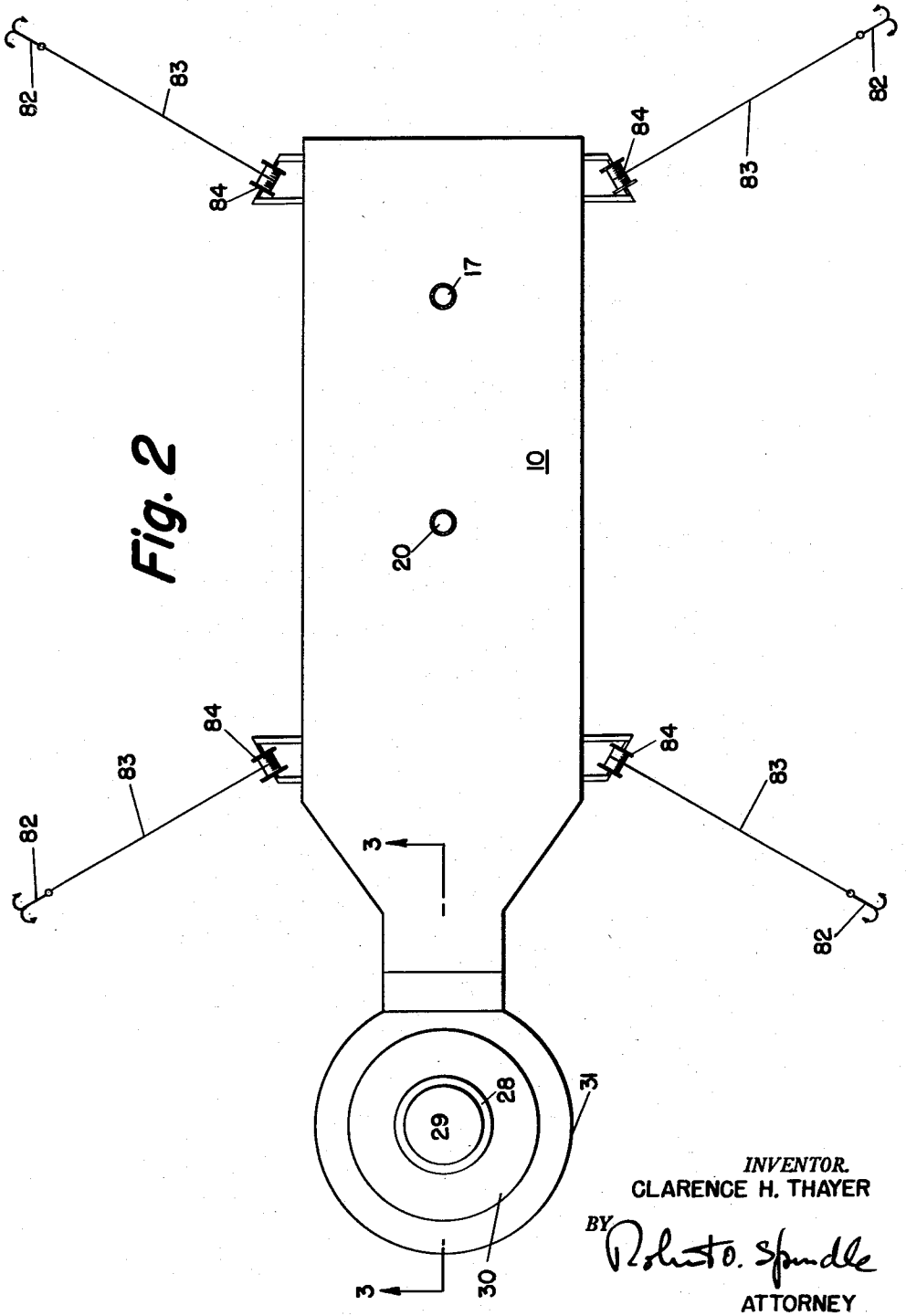

Fig. 2

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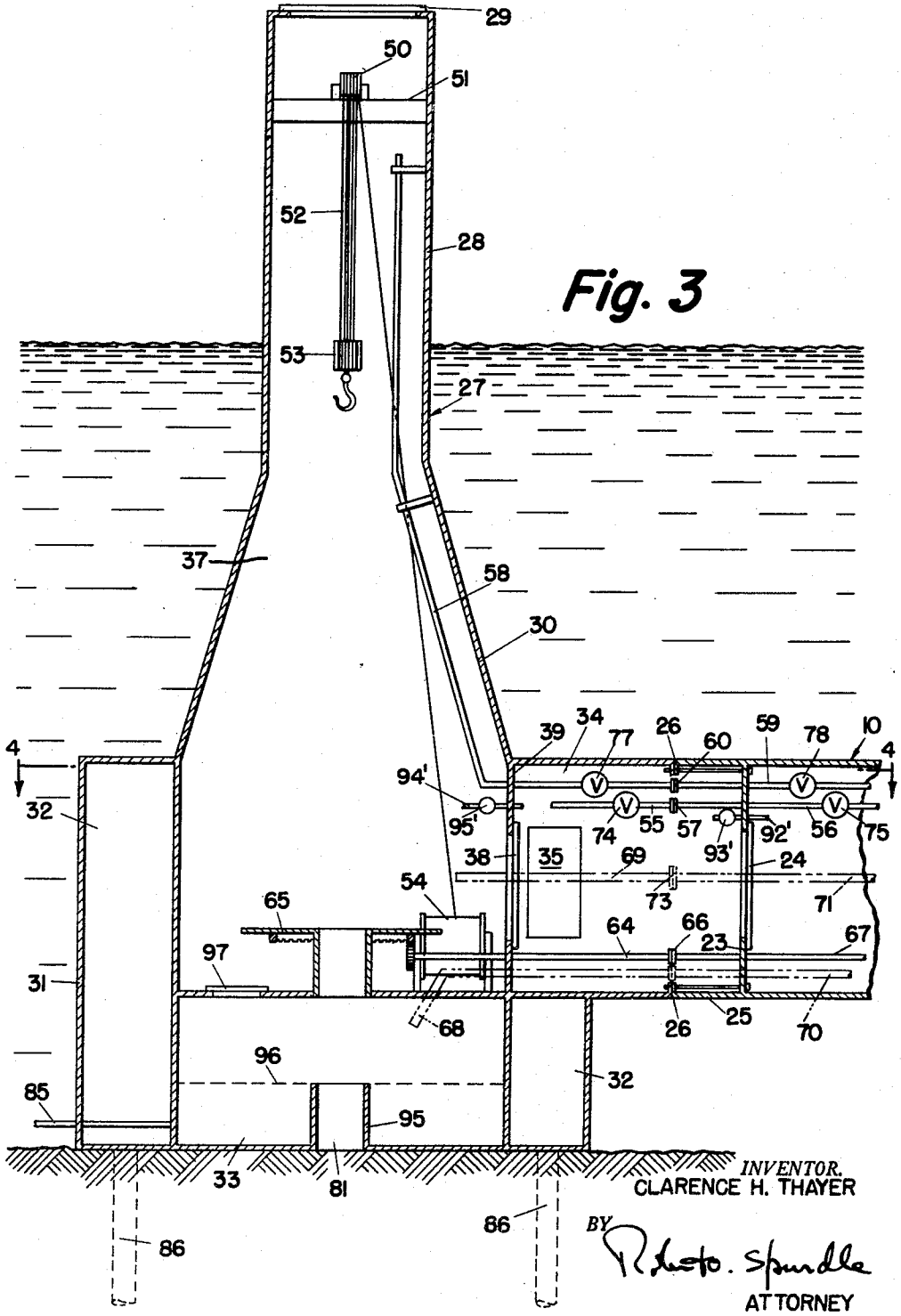
Fig. 3



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UNDERWATER DRILLING RIG

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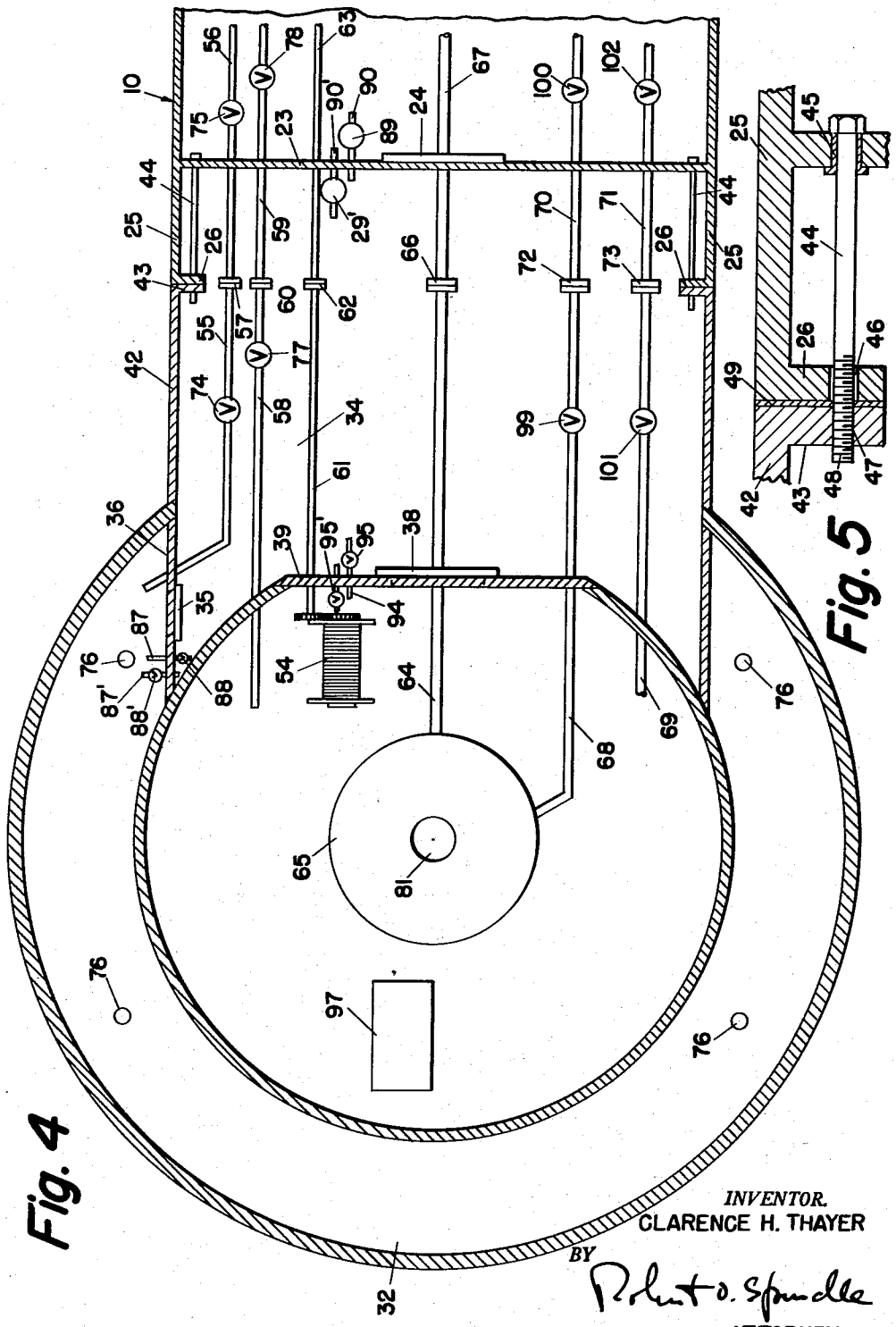

Fig. 4

Fig. 5

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2,937,006

UNDERWATER DRILLING RIG

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Application May 17, 1957, Serial No. 659,868

5 Claims. (Cl. 255—2.5)

This invention relates to an apparatus for drilling wells beneath the surface of a body of water, and more particularly to an apparatus permitting continuous drilling regardless of weather conditions.

In drilling oil wells in offshore locations, such as in the Gulf of Mexico, it has been customary either to build permanent-type drilling platforms carried on piling reaching down into the ocean floor, or in shallower waters, to use, as supports for the derrick and drilling machinery, barges supported on stilts on pontoons, which may be sunk to the bottom. Alternatively, the barge may be supported by hydraulically operated legs which may be driven down to the bottom and upon which the barge may be lifted above the surface of the water so as to be relatively unaffected by wave motion. Such barges, while they may be moved from one location to another, have the disadvantage of being extremely expensive to build and maintain, and the permanent-type drilling platforms have the disadvantage that they usually do not have facilities for the storage of drilling mud, and must receive their mud supplies from a service barge tied up alongside. In the event of a storm of any consequence, the service barge must be taken off to safety, and drilling must be suspended until the storm is over. In addition, both types of structures present large surface areas above water, and when winds of hurricane force are encountered, severe wind damage almost invariably results.

It is an object of this invention to provide a derrick structure which may be securely anchored to the bottom of a lake, ocean or bay, and which presents a minimum surface exposed to the action of wind and waves.

It is a further object of this invention to provide, in combination with said derrick, an underwater drilling chamber containing whatever prime movers, mud supply, and pumps may be necessary for the drilling operation, and which may readily be detached therefrom for removal to a new drilling location upon the completion of a well, leaving the derrick as a permanent structure to allow access to the well for maintenance or other purposes.

It is still another object of this invention to provide an underwater drilling rig, the operation of which is not affected by surface weather conditions.

The foregoing objects are attained in accordance with the present invention by providing a derrick in the form of a watertight caisson which may be sunk to the bottom of the ocean floor and firmly secured thereon. After the caisson is set in place, water is displaced therefrom by compressed air, and drilling is commenced under pressure and is continued until surface casing can be set and sealed within the caisson, at which time, air pressure can be reduced to atmospheric. Compressed air, power for the rotary table and draw works, and drilling mud is furnished from a submersible barge which is connected to the caisson near the bottom thereof. Access to the caisson from the barge is had via a series of watertight doors which may be opened once the caisson has been freed of water. Surface air is supplied to the barge by means of a tube extending from the barge to the surface, and terminating in a snorkel device to prevent access of water thereto. A similar snorkel tube is provided to carry away exhaust gases and foul air from the barge to the surface.

The caisson is of such a length as to extend somewhat above the water level when it is fixed in place on the bottom, and is provided at its upper end with an air and watertight door which is normally open during drilling operations, once surface casing has been set. Additional drill pipe, casing, and whatever other supplies are needed for the drilling operation can be passed down to the interior of the caisson through this door from a supply vessel. In case of a storm, the door can be closed to prevent entry of water, and drilling can be continued with the door closed until the storm abates, using the supply of drill pipe already contained within the casing. Since the upper part of the caisson is of relatively small cross-section, and is of solid construction, even winds of hurricane force will cause no damage. Since the major part of the structure, and its attendant submerged barge, are resting on the ocean bottom, below the reach of wave action, no damage can result thereto.

After the well has been completed, all watertight doors between the caisson and the barge are closed, and the barge then may be released from engagement with the caisson, refloated, and towed to a new location at which it is connected with a new caisson, to furnish power for drilling at the new location.

In order that those skilled in the art may more fully appreciate the nature of my invention, an embodiment will be described in detail in connection with the accompanying drawings, in which:

Fig. 1 is an elevational view, partly in cross-section, of one form of the apparatus of the present invention as it would appear when in place on the sea bottom;

Fig. 2 is a plan view of the apparatus, resting on the bottom, illustrating means for positioning the barge and its attached caisson;

Fig. 3 is a vertical cross-sectional view of the caisson taken along line 3—3 of Fig. 2;

Fig. 4 is a horizontal cross-sectional view of the caisson taken along line 4—4 of Fig. 3; and

Fig. 5 is a detail of one form of a means for securing the barge to the caisson.

Referring now more particularly to Figs. 1, 3 and 4, a submersible barge is indicated generally at **10**. Barge **10** is divided into an after compartment **11** for storage of supplies and living quarters for the drilling personnel, a main machinery compartment **12**, ballast tank **13**, and mud tank **14**, which is provided with baffles **15** to facilitate settling out of well cuttings. The necessary drilling machinery is indicated generally by block **16**, since it is impractical to illustrate each individual piece of equipment. Generally, however, drilling equipment **16** will include prime movers for driving a rotary table, the draw works hoist, and other auxiliary equipment, together with mud pumps, air compressors, electrical generating equipment, and other minor pieces of equipment. A flexible air intake line **17** connects with compartment **11**, and terminates in a float **18** and snorkel device **19**. A gas exhaust line **20** connects with machinery compartment **12** for removing engine exhaust gases, and terminates in float **21** and snorkel device **22**.

Barge **10** is fitted at its forward end with bulkhead **23**, which has an opening which may be sealed by watertight door **24**, as may be more clearly seen in Figs. 3 and 4. The barge terminates in extension **25**, which carries an internal flange **26**.

Drilling operations are carried on in a caisson, indicated generally at **27**. Caisson **27** consists of an upper tubular derrick section **28**, which may be closed at its upper end by air lock **29**, a conical section **30**, and base section **31**. Derrick section **28** is sufficiently high that

when the rig is placed in position on the sea bottom, it will extend above the surface of the water. Base section 31 is divided into an annular compartment 32, cellar compartment 33, and communication passageway 34 which is open at its outside end and terminates in inturned flange 43. Access may be had to annular compartment 32 from passageway 34 via watertight door 35 in bulkhead 36, and access to drilling compartment 37 from passageway 34 may be had via watertight door 38 in bulkhead 39.

In preparing to move the rig to the desired location, caisson 27 and barge 10 are placed in a dry dock and are secured together as by screw bolts 44 passing through bulkhead 23 and flanges 26 and 43. As may be more particularly observed in Fig. 5, bolt 44 passes through a bushing 45 which provides a watertight seal around bolt 44. The bolt 44 passes through an enlarged opening 46 in flange 26 and through a threaded opening 47 in flange 43, the threads of which mesh with the threads 48 on bolt 44. The bolts may then be turned to pull flange 43 tightly against flange 26, a sheet of gasket material 49 being interposed between the flanges to insure that the connection between barge 10 and caisson 27 is watertight.

Air lock 29 is then opened and draw works, comprising upper block 50 mounted on support 51 in the upper part of derrick section 28, drilling line 52, traveling block 53 and hoist drum 54 are then installed. Tank 14 is filled with drilling mud, and sufficient drill pipe and casing to set surface casing is taken into drilling compartment 37. Sufficient fuel and other supplies to permit operation until surface casing can be set is loaded aboard barge 10, and a quantity of sectional anchor piling is placed in annular compartment 32.

Air line 55 leading to annular chamber 32 is then connected with line 56, leading to an air compressor in machinery block 16, as by flange connection 57, and air line 58 leading to drilling chamber 37 is similarly connected to line 59 as by flange connection 60. Drive shaft 61 for hoist drum 54 is connected by flanges 62 to shaft 63, leading to a source of power in machinery block 16, and drive shaft 64 for rotary table 65 is connected by flanges 66 to shaft 67, also leading to a source of power in machinery block 16. Pressure tight bushings (not shown) are provided at the points where shafts 61, 63, 64 and 67 pass through bulkheads 23 and 39. Mud lines 68 and 69 are connected to lines 70 and 71 by flanges 72 and 73, and watertight doors 35 and 38 are secured.

Water is then admitted to the dry dock to float the rig. During the floating operation, valves 74 and 75 in air lines 55 and 56 are controlled to admit air to annular chamber 32 under pressure such as to prevent entry of water into annular chamber 32 through openings 76 in its bottom. Valves 77 and 78 in air lines 58 and 59 and valve 79 in air bleed line 80 leading to exhaust line 20 are controlled to supply sufficient air pressure to drilling chamber 37 to allow the entrance thereto via opening 81 of sufficient water to act as ballast, but not so much as to impart negative buoyancy to caisson 27. Trim of the rig is regulated by admitting a controlled amount of water to ballast tank 13.

The rig may then be towed to the desired location, at which point sufficient air is bled from drilling chamber 37 and ballast tank 13 to impart a slight negative buoyancy to the rig, allowing it to settle gently to the bottom, final positioning of the rig on the bottom being effected by means of anchors 82, which are carried out and dropped by the towing vessel. Once the anchors 82 are dropped, barge 10 can be positioned by pulling on anchor lines 83 through winches 84 which are operated from inside barge 10.

After the rig is positioned, ballast tank 13 is filled with water, and bleed valve 79 is fully opened to allow free access of water to drilling chamber 37 through a plurality of pipes 85 leading from the outside of caisson 27 to cellar compartment 33, in order to fix the rig firmly on the bottom. Annular compartment 32 may then be entered, while maintaining the air pressure therein, and anchor legs 86 are driven downwardly into the ocean bottom through openings 76. Air bleed lines 87 and 87', controlled by valves 88 and 88', are provided for equalizing the air pressure between annular compartment 32 and passageway 34 prior to opening door 35. Similar lines 89 and 89', and valves 90 and 90' are provided to equalize air pressure between passageway 34 and the interior of the barge 10 prior to opening door 24. It will be observed that this arrangement provides a compression-decompression chamber to protect operating personnel against the hazards of working under air pressure.

After the anchor legs 86 are driven into place, openings 76 are sealed off, after which pressure in annular compartment 32 may be released. Compartment 32 is then filled with concrete in order to hold caisson 27 firmly on the bottom when drilling compartment 37 is pumped clear of water. Bleed valve 79 is now closed, and compressed air is admitted to drilling compartment 37 via line 58 under pressure sufficient to force the water contained therein out through pipes 85. The drilling compartment may now be entered through door 38, after pressure has been equalized between this compartment and passageway 34 by manipulation of valve 94 in bleed line 95. A second bleed line 95' and valve 94' is provided so that pressure between drilling compartment 33 and passageway 34 may be equalized from inside the compartment 37 by personnel desiring to leave this compartment. Cellar compartment 33 is now filled with concrete through hatch 97 to the top of pipe section 95, as illustrated by the dotted line 96 in Fig. 3. Drilling is now commenced under air pressure and is continued until surface casing can be set and a seal placed between the surface casing and pipe section 95, after which pressure in drilling compartment 37 can be released and air lock 29 may be opened to receive from a supply vessel further supplies of drill pipe and other materials required in the drilling operation.

Drilling continues with air lock 29 open until the approach of a storm, at which time lock 29 is closed to prevent access of water to drilling compartment 37. Drilling may continue uninterruped by the storm so long as the supply of drill pipe holds out, since an ample supply of air to operate the engines driving the drilling machinery is available through snorkel device 19 and air intake line 17. After the storm has subsided, air lock 29 may be reopened. As may be seen from the drawings, very little surface area of the rig is exposed to the action of wind and waves, so that drilling may be continued in perfect safety even though storms of hurricane intensity may be encountered.

After the well has been completed, the connections between air lines 55 and 56, air lines 58 and 59, shafts 61 and 63, shafts 64 and 67, mud lines 68 and 70, and mud lines 69 and 71 are broken, valves 74, 75, 77, 78, 99, 100, 101 and 102 are closed, and doors 38 and 24 are sealed. Bolts 44 are then turned to unmake the connection between flanges 43 and 26, and to release barge 10 from caisson 27, and sufficient mud and ballast is blown out of mud tank 14 and ballast tank 13 to impart positive buoyancy to barge 10 and float it to the surface, where it may be taken in tow for affixation to another caisson in preparation for a second drilling operation. After the barge 10 has surfaced, personnel may leave the barge through hatch 98.

It is realized that underwater drilling platforms intended to be left in place as permanent structures similar in appearance to caisson 27 have heretofore been proposed, such as the platform illustrated in U.S. Patent 2,171,672 to Plummer. Such prior art platforms must of necessity be made of sufficient size to accommodate all of the drilling machinery, and their upper sections must be of sufficient diameter to permit recovery of the drill-

ing machinery therethrough. Since in the apparatus of the present invention the drilling machinery is carried in the detachable barge, the drilling compartment need only be large enough to contain the rotary table and hoist drum, resulting in a considerable saving in construction cost as compared to the prior art structures.

The invention claimed is:

1. A platform adapted for use in drilling a well under a body of water including in combination a caisson having an enlarged lower portion, means dividing said lower portion into an outer annular compartment and a central compartment, said central compartment being in free communication with the upper end of the caisson, said annular compartment having a floor, a port in said floor communicating with the exterior of the caisson, said central compartment also having a floor, and a port in the floor communicating with the exterior of the caisson, means for admitting air under pressure to said annular compartment and to said central compartment, a passageway in said lower portion terminating at one end at said dividing means and having a port at the other end, a first watertight door in said dividing means communicating with said passageway, a second watertight door in said passageway connecting with said annular compartment, a submersible barge connected to said port in watertight relationship thereto, a third watertight door in said barge communicating with said passageway, means operable from within said barge for disconnecting the barge from the port, access means adjacent the upper end of the caisson, and means for sealing the access means against the passage of fluid.

2. Apparatus according to claim 1 including an air intake line communicating with the barge, a gas outlet line connecting with the barge, and floating snorkel means associated with each of the said intake and outlet lines for preventing the entry of water into the said lines.

3. The apparatus of claim 2 including a rotary drilling table and a draw works located in said central compartment, power means located in the barge for operating said drilling table and draw works, and power take-off means operably connecting said drilling table and draw works with said power means.

4. The apparatus of claim 3 including a mud tank in the barge, a mud supply line running from the mud tank to the central compartment, pump means interposed in the mud supply line, a mud return line running from the central compartment to the mud tank, and valve means in said mud supply line for controlling the flow of mud therethrough.

5. The apparatus of claim 3 including a plurality of anchor legs attached to and extending downwardly from the caisson adjacent the annular compartment.

References Cited in the file of this patent

UNITED STATES PATENTS

962,019	Flood et al.	June 21, 1910
2,534,480	Shannon	Dec. 19, 1950
2,669,846	Shannon	Feb. 23, 1954
2,691,272	Townsend	Oct. 12, 1954