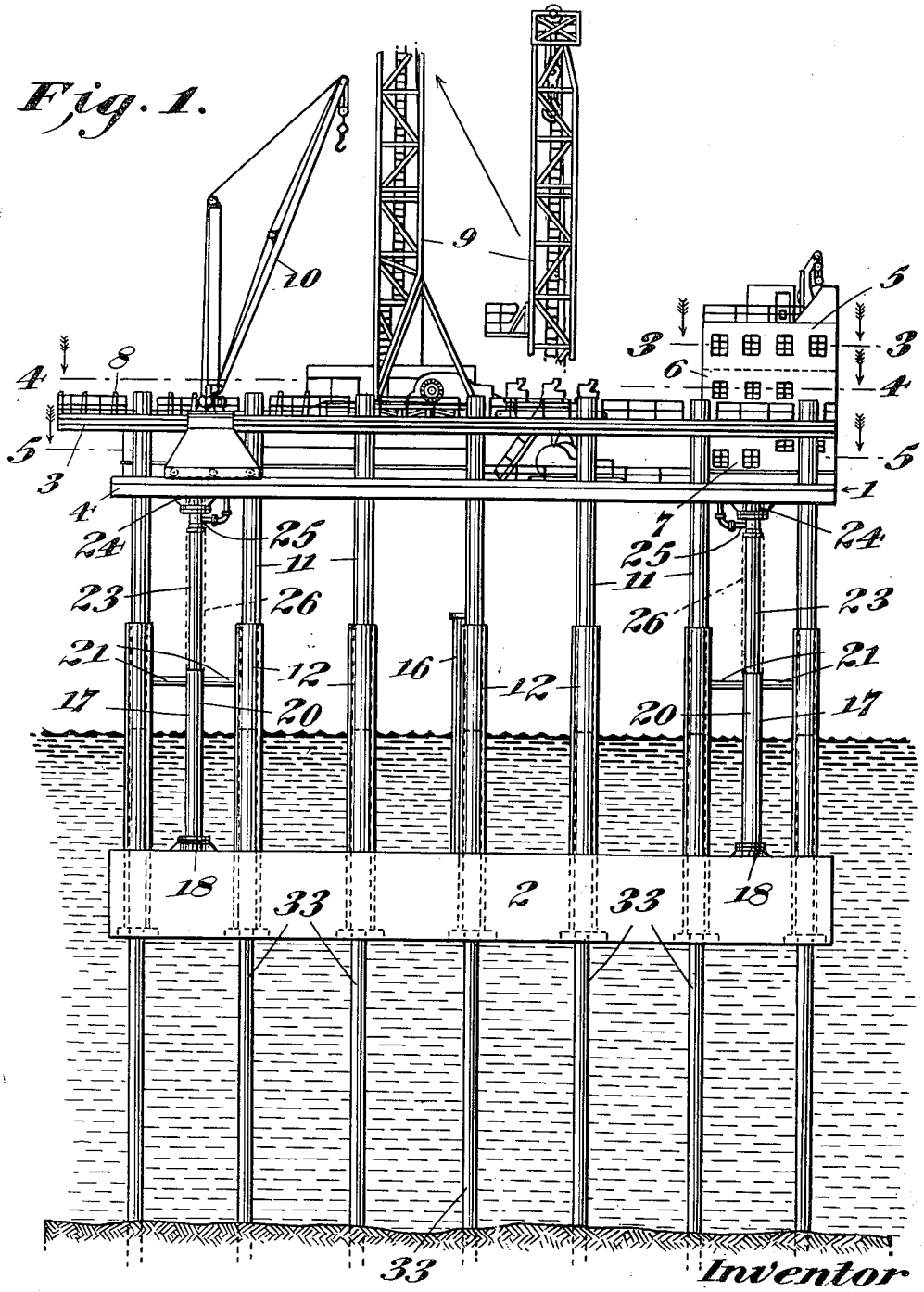
Nov. 27, 1956 E. C. RECHTIN 2,771,747

OFFSHORE DRILLING BARGE

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Fig. 1.



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OFFSHORE DRILLING BARGE

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Fig. 2.

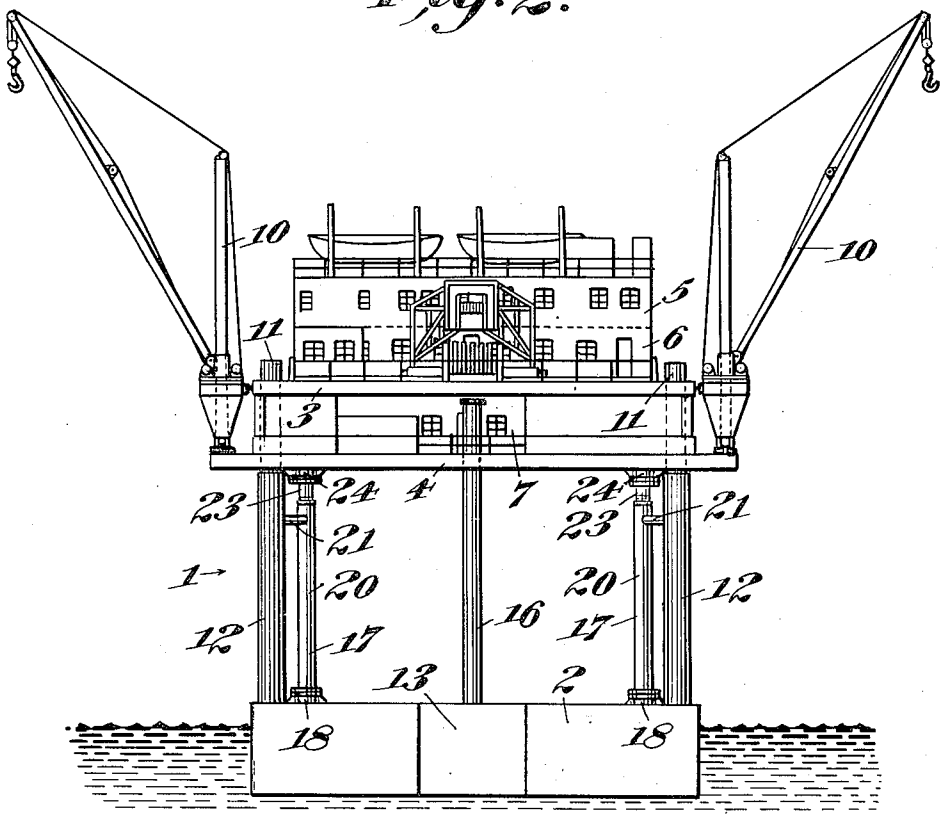
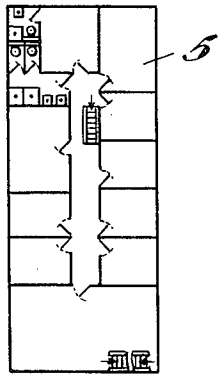


Fig. 3.



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Fig. 4.

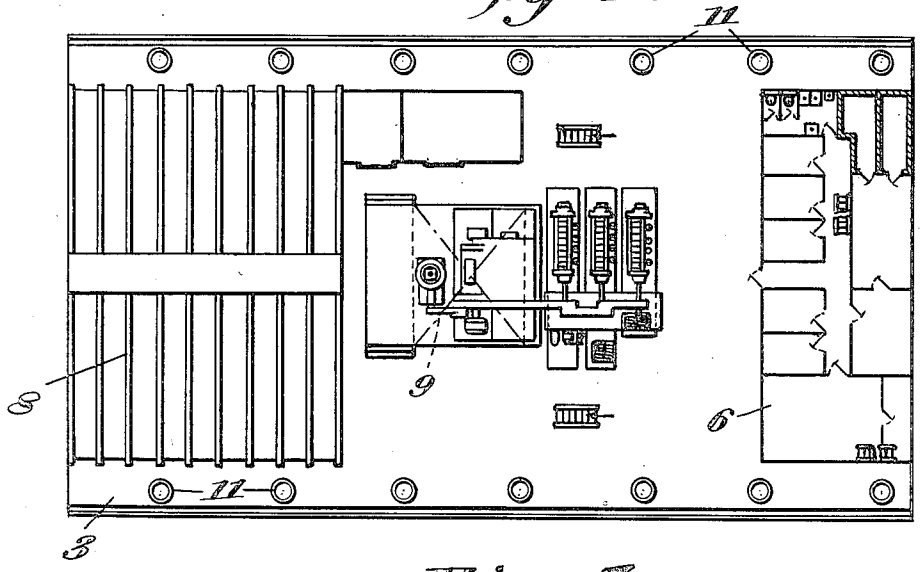
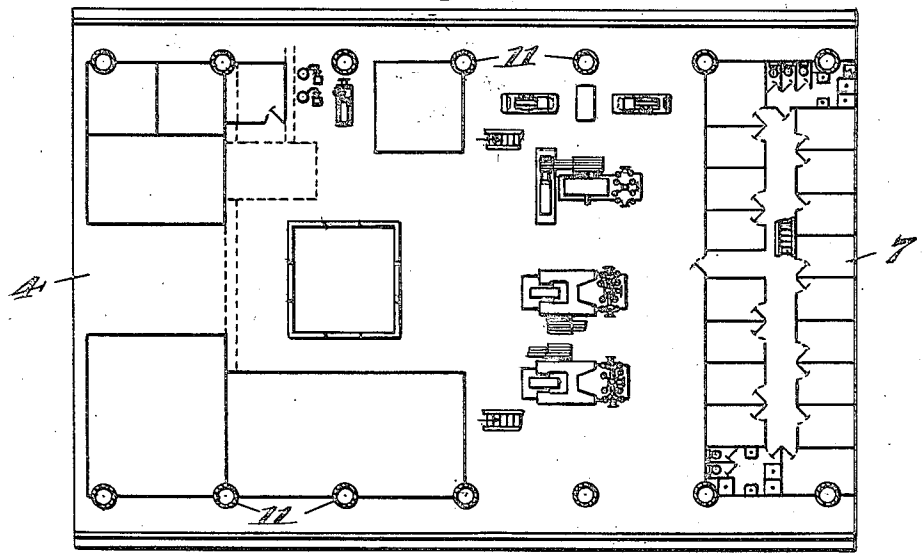


Fig. 5.



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Fig. 6.

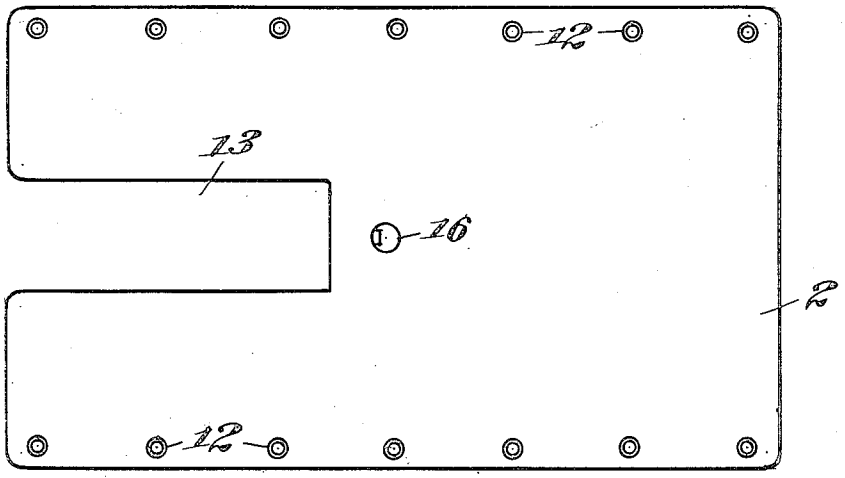
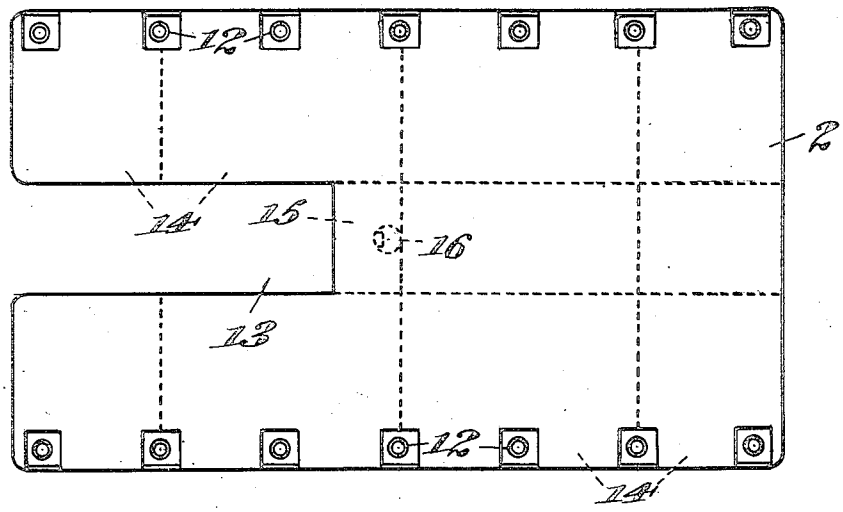


Fig. 7.



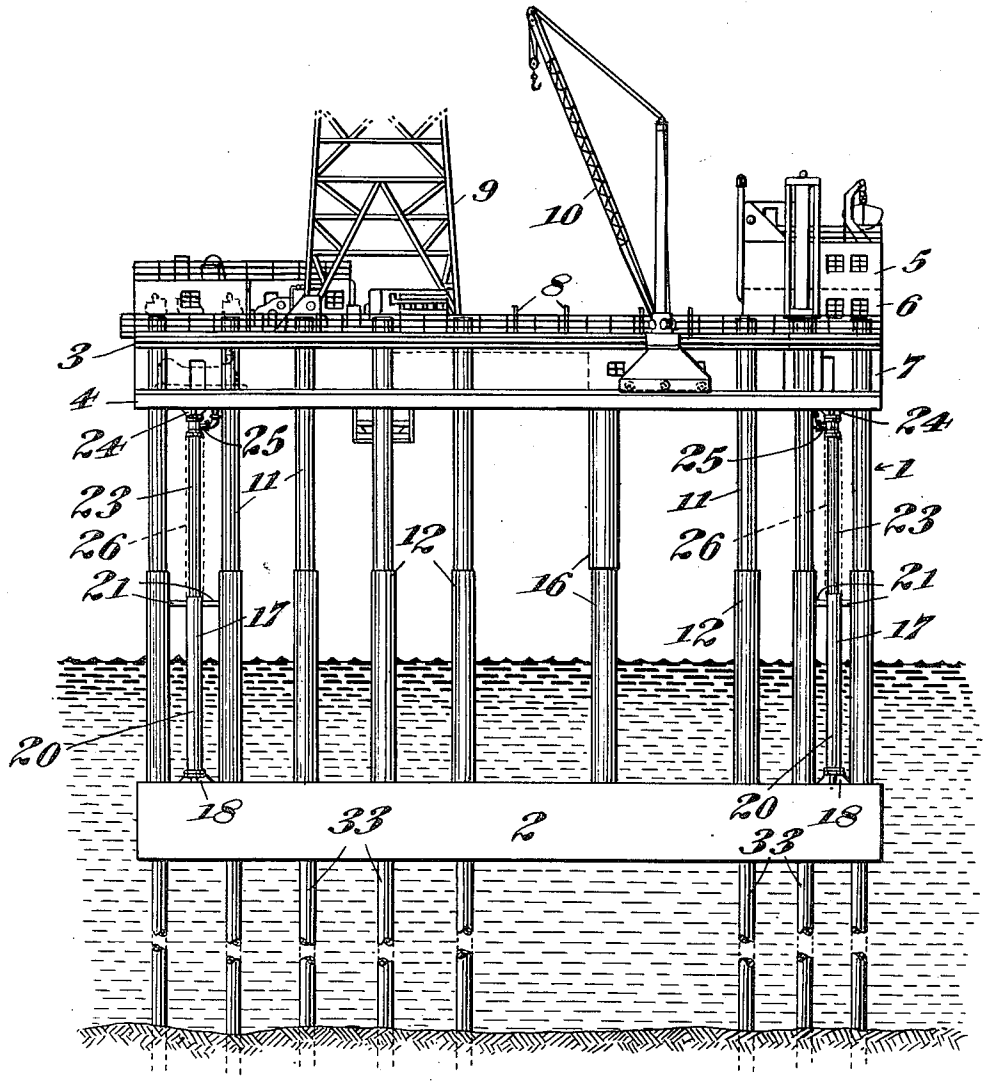
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OFFSHORE DRILLING BARGE

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Fig. 8.



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Fig. 9.

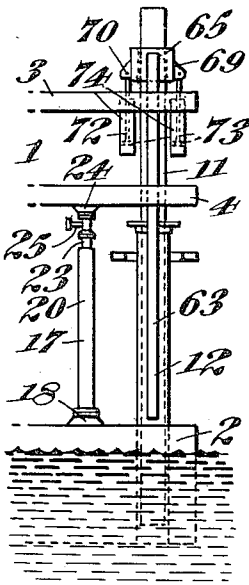


Fig. 10.

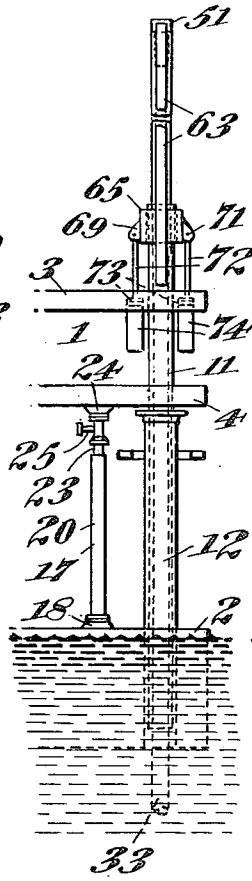


Fig. 11.

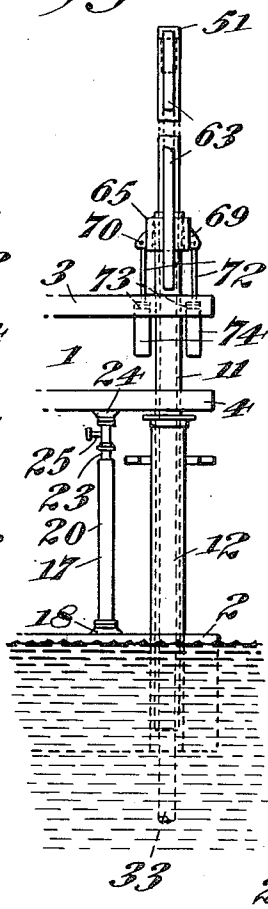
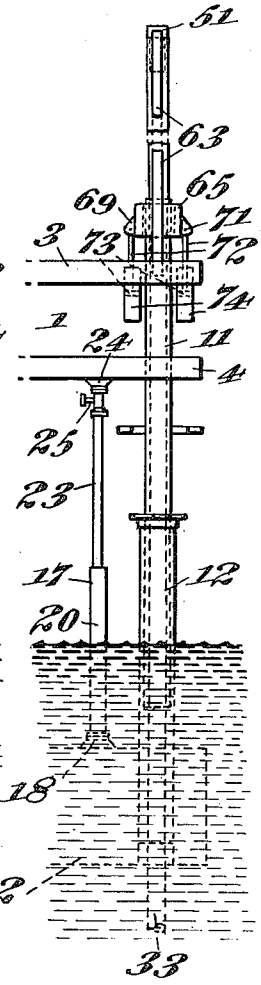


Fig. 12.



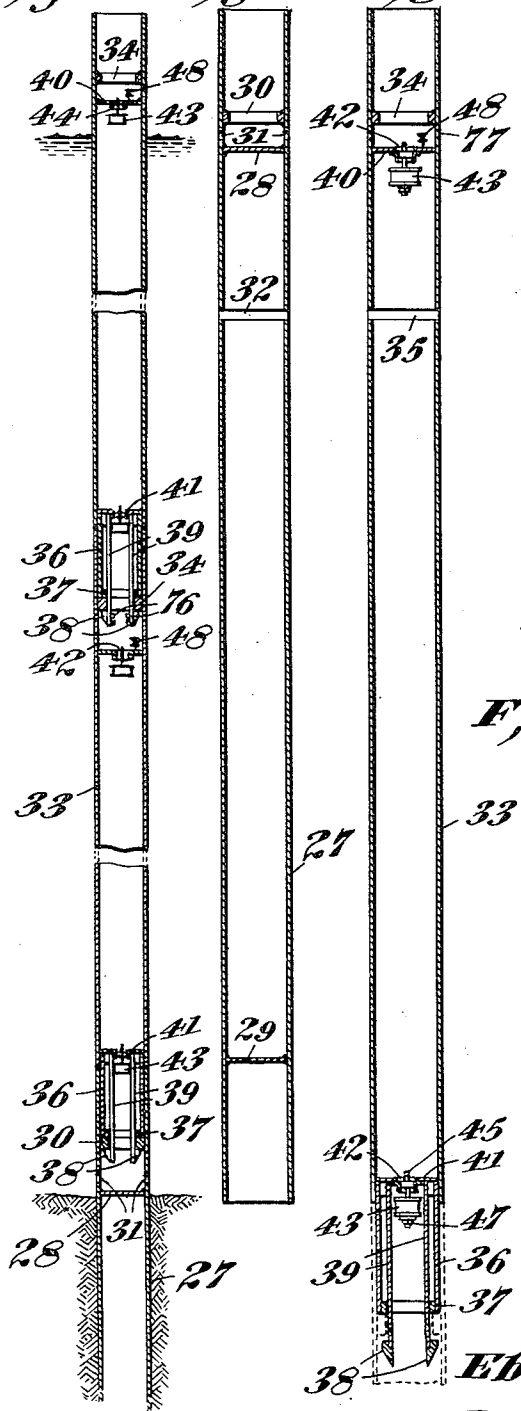
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OFFSHORE DRILLING BARGE

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Fig. 13. Fig. 14. Fig. 15. Fig. 16.



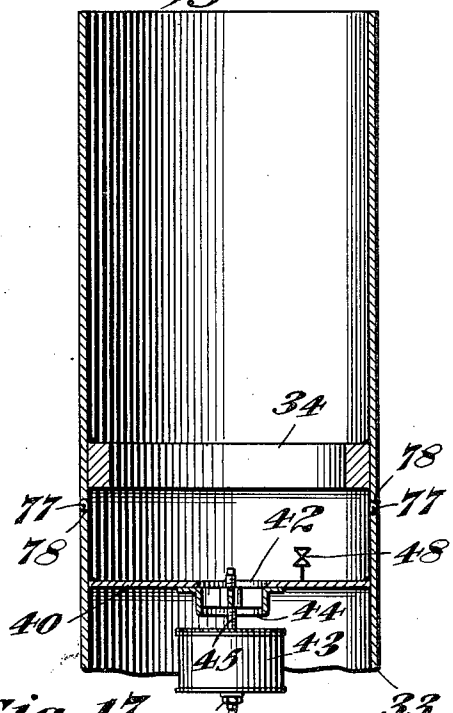
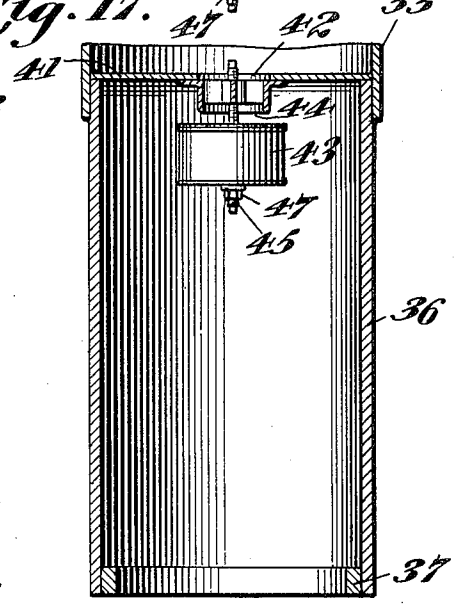


Fig. 17.



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OFFSHORE DRILLING BARGE

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Fig. 18

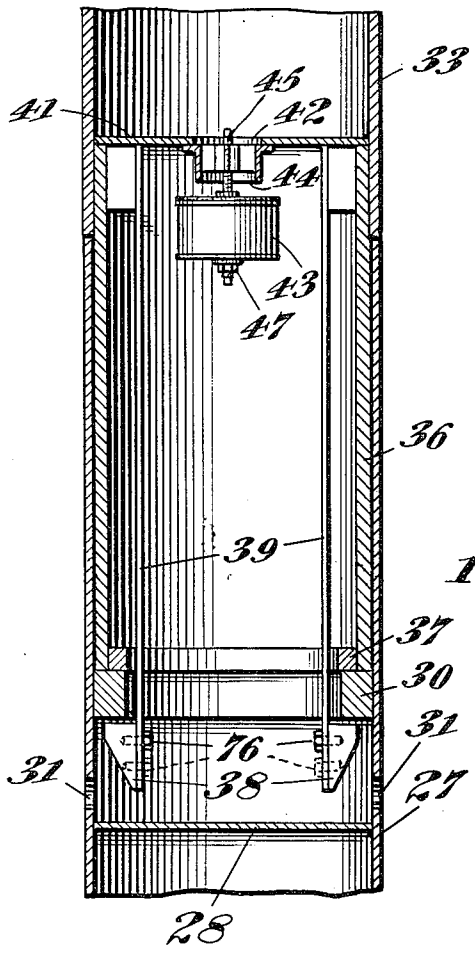


Fig. 19.

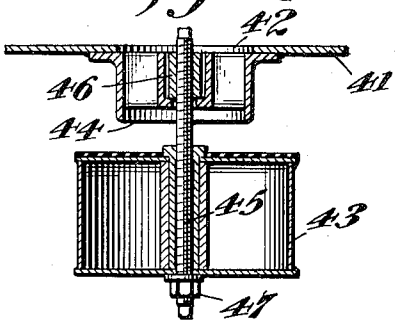


Fig. 20.

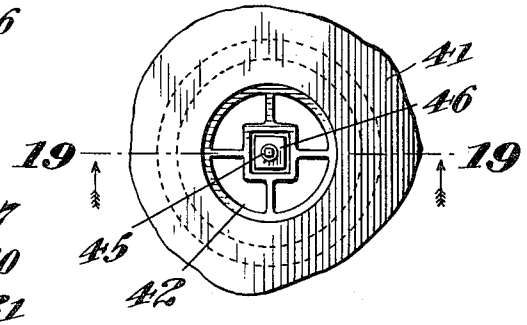
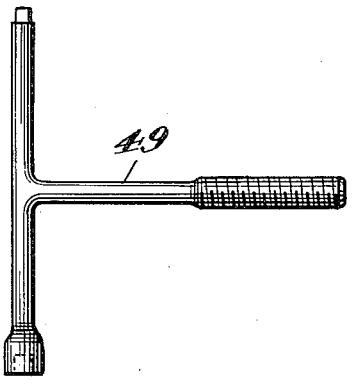


Fig. 21.



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OFFSHORE DRILLING BARGE

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Fig. 22.

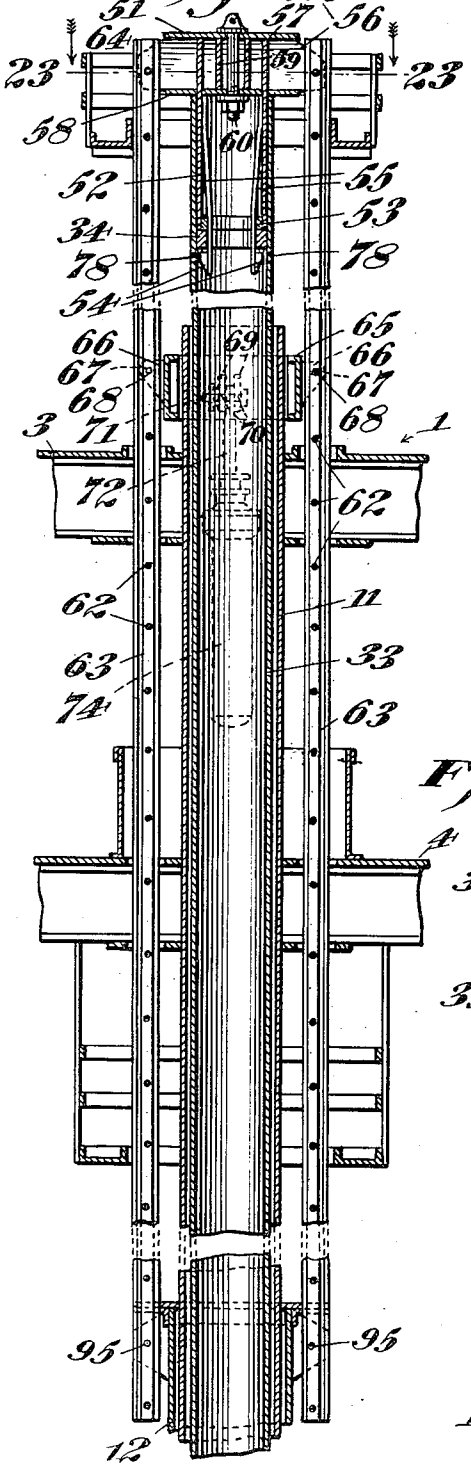


Fig. 23.

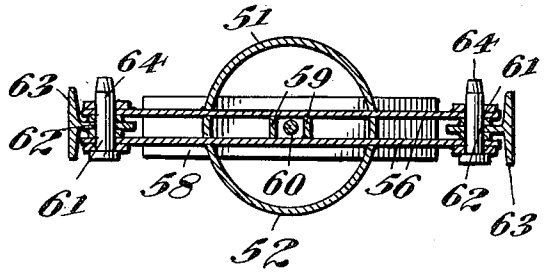


Fig. 24.

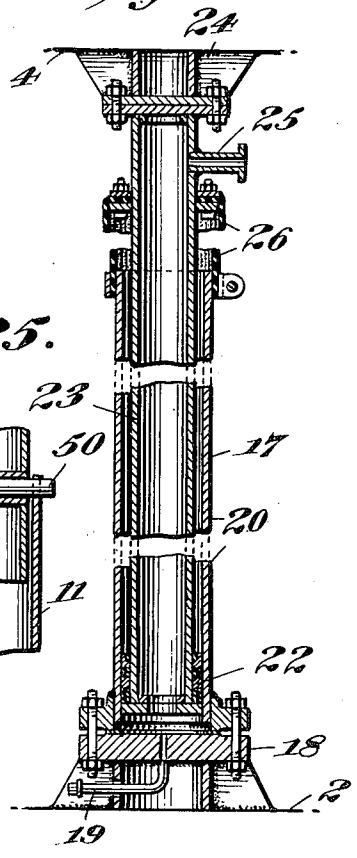
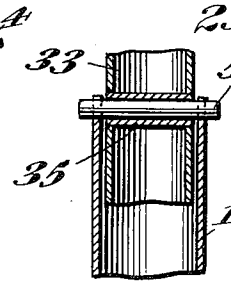


Fig. 25.



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Fig. 26.

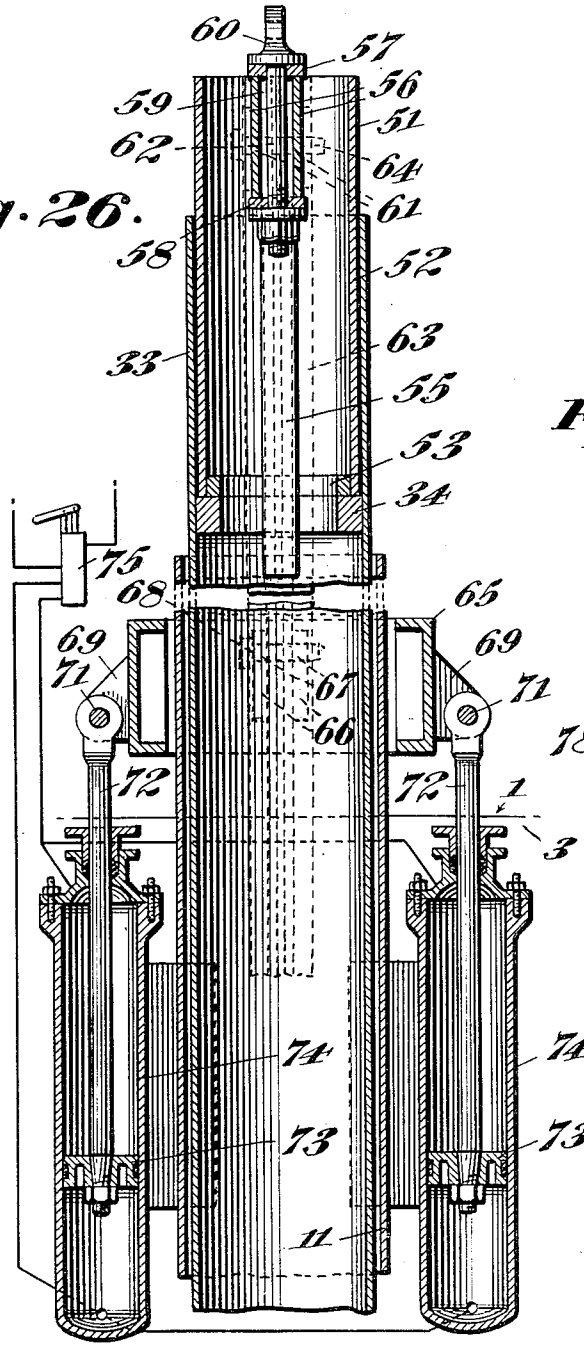
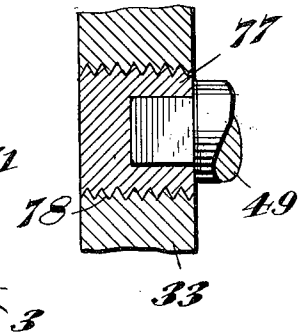


Fig. 27.



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United States Patent Office 2,771,747 Patented Nov. 27, 1956

2,771,747

OFFSHORE DRILLING BARGE

Eberhardt C. Rechtin, Beaumont, Tex., assignor to Bethlehem Steel Company, a corporation of Delaware

Application July 19, 1950, Serial No. 174,691

29 Claims. (Cl. 61—46.5)

This invention relates to a barge which has drilling apparatus mounted thereon to be used in drilling oil wells in land submerged by water, and more especially to provide a foundation and support for the barge which can be floated into position for a well drilling operation and adapted to be removed and conveyed to another position after it has served its purpose.

The drilling of oil wells in relatively shallow waters as in the Gulf of Mexico adjacent to the states of Texas and Louisiana has resulted in the extensive use of piling to support the drilling platforms. Hitherto piling has usually been considered a portion of a permanent structure, such as a building or a bridge. Now, however, since some of the holes drilled are probably going to be unproductive, the problem of economically recovering the piling has arisen.

The Federal Government also will not permit operators to leave piling protruding appreciably above the bottom of the Gulf, or to abandon platforms when not in use, because of the dangers to navigation.

At present the platforms are in fairly shallow water and the piling used has been steel tubing of moderate diameter, of an average of 24 inches. Such piling can usually be pulled, jetted or worked loose by equipment of reasonable size. In some cases, however, difficulty has been encountered even with this smaller piling and the practice of dynamiting the piling from within has been resorted to. This practice is destructive and dangerous and otherwise unsatisfactory. Underwater cutting has been tried but can be successful only at moderate depths.

As exploration continues it will be necessary to work in greater and greater depths, farther and farther out to sea. This will require larger and heavier piling of greater diameter for two reasons. First, of course, is the necessity of providing a stiff and rigid support for the drilling platform to resist the side thrust of wind and wave. Secondly the unsupported length of piling increases with the depth. Since the diameter of the tubing will increase with the depth of water and the thickness of plate used will also increase proportionately it follows that the weight of piling to be handled will increase about as the cube of the depth of the water worked in.

Experience has shown that the effort required to pull a pile after it has set may vary from two to eight times the force necessary to drive it. Obviously, therefore, the super-piling needed for the greater depths contemplated will require lifting equipment of great size and cost. Floating lifting equipment capable of pulling even 200 tons is very rare, yet we must consider piling capable of supporting 200 tons or more consequently requiring a lifting effort of 400 to 1600 tons.

One of the objects of the invention relates to a barge providing a combination comprising a drilling platform and superstructure and a buoyant member of the pontoon type for temporarily supporting the drilling platform and superstructure and particularly useful for transporting well drilling equipment and for firmly supporting said equipment at the well drilling location. The drilling platform and superstructure provided with hollow guide tube members which extend downwardly therefrom and are in telescopic relation with hollow guide tubes mounted in and extending upwardly from the buoyant member adapted to receive pile members constituting the legs for supporting the drilling platform and superstructure.

Another object of my invention relates to the design of large piling to overcome the objection of great handling weight and the extreme difficulty of withdrawing the piling after use.

Another object of the invention relates to a practical means of transporting of piling to a marine site by means of built-in buoyancy and means for retaining the buoyancy in the pile while placing it in position.

Another object of the invention relates to a means for making a joint between sections of piling without recourse to riveting, welding, or use of tools.

A further object of the invention is to provide means for supporting the strings of piling before the lower ends of the strings of piling reach the bottom of the body of water.

Another object of the invention relates to the means for controlling the sinking and raising of the buoyant members or pontoon.

Another object of the invention relates to the manner of transferring the load and weight of the drilling platform and superstructure from the buoyant member to the fixed piling.

Another object of the invention relates to the means of breaking away or detaching the retractable sections of piling from the expendable sections of piling and ensuring that the break will be made at that point and nowhere else.

Another object of the invention relates to the manner of coupling and uncoupling the retractable piling sections.

Other and further objects of the invention will be readily apparent when the following description is considered in connection with the accompanying eleven sheets of drawings, wherein:

Figure 1 is a side elevation showing the general arrangement of my offshore drilling barge in the drilling position.

Fig. 2 is an end elevation of the offshore drilling barge shown in Fig. 1, but shown in the towing position.

Fig. 3 is a diagram of the third story of the quarters for a portion of the crew for operating the barge taken on the line 3—3 of Fig. 1.

Fig. 4 is a top plan view of the upper deck or drilling platform and showing a diagram of the second story for another portion of the crew quarters taken on the line 4—4 of Fig. 1.

Fig. 5 is a top plan view of the lower deck or platform and showing a diagram of the first story for additional members of the crew, taken on the line 5—5 of Fig. 1.

Fig. 6 is a top plan view of the pontoon member of the barge.

Fig. 7 is a bottom plan view of the pontoon member of the barge.

Fig. 8 is a side elevation of an offshore drilling barge in the drilling position constructed and arranged in a somewhat different manner than that shown in Fig. 1.

Fig. 9 shows diagrammatically the condition of the barge for towing.

Fig. 10 illustrates diagrammatically the equipment adjusted to be ready to secure the piling.

Fig. 11 illustrates diagrammatically the position of the

parts secured to the piling with the pontoon for the barge ready to be submerged.

Fig. 12 illustrates diagrammatically the pontoon of the barge submerged in the position it will assume during the drilling operation.

Fig. 13 is a vertical section showing a schematic arrangement illustrating the manner of assembling and connecting the expendable pile sections to the retractable piling sections.

Fig. 14 is a vertical section of one of the expendable piles.

Fig. 15 is a vertical section of one of the retractable piles.

Fig. 16 is an enlarged vertical section of the upper end portion of one of the retractable pile sections showing more clearly the end valve closure.

Fig. 17 is an enlarged vertical section of the lower end of a retractable pile section without the spring latching mechanism mounted thereon.

Fig. 18 is an enlarged vertical section illustrating the upper end of an expendable pile section and the lower end of a retractable pile section and showing the connecting sleeve with the latches mounted thereon.

Fig. 19 is an enlarged vertical section of a detail of one of the check valves illustrating the manner of attaching it to one of the bulkheads taken on the line **19—19** of Fig. 20.

Fig. 20 is a top plan view of one of the check valves with a portion of the bulkhead attached thereto.

Fig. 21 is a side elevation of a multiple wrench used in connection with this apparatus.

Fig. 22 is a vertical section showing a lifting cap attached to the upper end of a pile and the yoke, upper ends of the upper and lower telescopic tubes also in section, and illustrating the manner of attaching T-bars to the lifting cap, yoke and the upper end of the lower tube.

Fig. 23 is a transverse section through the lifting cap taken on the line **23—23** of Fig. 22.

Fig. 24 is a vertical section of one of the hydraulic rams for controlling the submerging and raising of the pontoon member of the barge.

Fig. 25 is a detail section illustrating the manner of supporting a pile by means of a pin extending transversely through a pipe with the ends of the pin resting on the upper edge of the upper tube.

Fig. 26 is a vertical section illustrating a means for transferring the load or weight of the drilling platform and superstructure to the piling, and

Fig. 27 is an enlarged detail view of one of the flush plugs for one of the forcing holes showing the manner of applying the multiple wrench thereto.

Referring now to the various characters of reference on the drawings, the numeral **1** indicates the barge as a whole, comprising a pontoon member **2** and a superstructure having an upper deck **3** and a lower deck **4** forming the drilling platform and for carrying the required machinery for the purpose intended and further provided with three stories **5**, **6**, and **7** for the crew. The upper deck **3** forming the drilling platform is provided with a pipe rack **8** for the drill pipe or casing and a derrick **9** for manipulating the same, while the lower deck **4** is provided with movable cranes **10**.

The upper and lower decks **3** and **4** and superstructure thereon and the pontoon member **2** are connected together by means of telescopic tubes **11** and **12**. The upper tubes **11** being rigidly secured to the upper and lower decks of the superstructure and extend downwardly therefrom, while the lower tubes **12** have their lower end portions rigidly secured to the pontoon member **2** and extend upwardly therefrom.

The pontoon member **2** is formed with an open drilling bay **13** through which the drilling strings are lowered by the derrick **9** during the drilling operations and is further provided with ballast tanks **14** for water and the like and a pump room **15** with means mounted therein for controlling the supply of water to and from the ballast tanks, said pump room having an access trunk **16** thereto extending from the lower deck **4** to the pontoon member **2**.

In order to assist in submerging and raising the pontoon member rams **17** are provided which are connected to each corner of the lower deck **4** and the pontoon member **2**. These rams **17** as shown more clearly in Fig. 24 comprise a base member **18** having a drain **19** connected thereto, and an outer tubular cylinder member **20** which is connected near its upper end by braces **21** to a pair of the lower tubes **12**. A piston **22** is mounted for vertical movement in the tubular cylindrical member **20** and provided with a piston rod **23** which has its upper end secured to the lower deck **4** as at **24** and having a pipe connection **25** which extends to the lower deck **4** where the fluid pressure thereto is controlled.

In order to more fully protect the piston rod **23** it is provided with a waterproof collapsible boot **26**.

As shown in Figs. 2 and 9 the barge is illustrated in the towing position and the upper portion of the pontoon **2** extends above the water line. In this position the barge is towed to the desired locality to drill an oil well and anchored.

When the barge is in the drilling position as shown in Figs. 1, 8 and 12 the pontoon member **2** is submerged and the upper and lower decks **3** and **4** and superstructure are supported on piles which are formed in sections.

It will be noted by referring more particularly to Figs. 13 to 18 inclusive that there are two types of piling sections shown which are intended to work together. One I designate as an "Expendable pile" and the other is named "Retractable pile."

The expendable pile **27** is merely a conventional piece of tubular piling of a diameter necessary to carry the load and is adapted to be driven into the soil and remain there permanently to form a foundation for the retractable piling sections. This expendable pile **27** is fitted with two bulkheads **28** and **29** to enclose its interior and to render it watertight and buoyant.

The lower bulkhead **29** is preferably of thinner material, lightly secured, and is expected to tear loose when the pile section is driven into the soil. The upper bulkhead **28** is of stouter material and should resist the driving particularly as it will be near the surface of the soil. A driving ring **30** is fitted near the upper end of the piling which also serves to catch a latch and drain holes **31** are formed in the upper end of the pile section between the bulkhead **28** and the driving ring **30** and is further provided with a transversely extending pipe **32** to receive a pin by means of which the pile section may be hoisted as will be described more fully hereafter.

It should be noted that these expendable piling sections can be made in any desired lengths, limited only by the handling equipment available.

The retractable piling section **33** consist also of tubing but preferably of thicker plating. This piling generally is expected to be free standing in water and consequently is designed to have sufficient stiffness to resist columnar bending and side thrust. It may be made in standard lengths of fifty feet each. The retractable piling section near its upper end is provided with a driving ring **34** and at an intermediate point with a transverse pipe **35** and the lower end of each section is fitted with a sleeve **36** which extends downwardly therefrom, and the lower end of the sleeve is heavily reinforced with a ring **37** intended to engage the driving ring fitted in the upper end of the next section below. Two latches **38** each operating on a long flat bar **39** are arranged to slip over the driving ring on the lower pile section and latch thereon, thereby preventing withdrawal. The retractable piling sections are each fitted with two bulkheads **40** and **41** near the ends. These bulkheads are permanent, each having a central opening **42** which may be opened or closed by a float valve **43**, adjustably mounted in relation to a valve seat **44** by means of a threaded bolt **45** and adjusting nuts

46 and 47. The upper bulkhead 40 is also provided with an air valve 48.

Assuming a location has been selected for attempting to drill an oil well the drilling barge (using this term, to designate the whole apparatus), is stocked with working materials such as mud, pipe, water, fuel and provisions and a crew abroad is towed to the site selected. The barge is then anchored. It is usual to drive a test pile of small diameter to develop data on the penetration necessary to support the desired loads. From this data it will be possible to select a length of expendable piling which when driven into the soil approximately its full length will provide the needed bearing. Such piling in desired lengths are fabricated ashore and floated to the location. Retractable piling section in sufficient numbers of units to reach the bottom are also fabricated ashore and floated to the site. In floating this retractable piling the valves 43 in the bulkheads 40 and 41 are closed manually using the multiple wrench 49 shown in Fig. 21. The pipe shown in both types of piling, extending from side to side as indicated by the numerals 32 and 35 provides a water-tight tube through which cables or pins can be passed while towing, lifting or handling the piling.

The first operation to be performed after driving the test pile is to drive the piling. It is desirable to sink several or all of the piling in sequence or simultaneously to obtain better alignment and to prevent undue strain on a single pile caused by the lateral movement of the barge. This is done by building up several strings of piling until the lower end of each string of piling is about five or ten feet above bottom and then releasing them in sequence or simultaneously, the piles being initially driven into the soil by their own weight.

In handling the sections of piling shown more particularly in Figs. 14, 15 and 25 in building up the strings of piling the pile itself will be handled by a crane using a sling adapted to engage a pin 50, as indicated in Fig. 25. These pins extend through the transversely extending pipes 32 and 35 provided for that purpose near the upper end of the piling sections with their ends projecting beyond the sides of the piling.

The expendable piling 27 is first placed in the telescoping tubing. This is done by inserting a pin 50 in the pipe 32 which is engaged by a sling and then raised by a crane into a vertical position and its lower end inserted in the upper end of the upper telescopic tube 11. It is then lowered until the projecting ends of the pin 50 engage the top end of the upper telescoping tube 11 thereby holding the piling section 27 in this position as shown in Fig. 25.

After the expendable piling sections 27 have been placed in position and supported as above described the retractable piling sections 33 are attached thereto. If one or more sections of retractable piling are necessary to create a pile long enough to be driven these can be connected as follows: A pin 50 is first inserted in the transversely extending pipe 35 and a sling attached thereto, a crane 10 then lifts the section of retractable piling clear of the water and both valves 43 are opened manually by means of the wrench 49. The crane then raises the section into a vertical position and the sleeve 36 at the lower end of the pile section is slipped into the upper end of the next lower pile until a bearing is obtained between the driving rings of the two pile sections. The latches 38 will have been forced inward and will have snapped over the driving ring of the lower pile. It is apparent that this process will consume only a small fraction of the time now used in welding sections of piling together. The pin 50 is now removed from the expendable piling and both sections are lowered by means of the crane until the ends of the pin 50 in the retractable piling section engage the top of the upper telescoping tube 11. This operation for the retractable piling sections 33 will be repeated until the lower end of the pile is just above the ground, the pin 50 holding the several sections pendant, while the crane is placing and securing additional sections in place. It will be understood that this supporting pin 50 has to be removed for the crane to lower the piling for each additional section.

After building up the strings of piling until the lower end of each string is just above the ground the piles are released and power driven.

As the piling is driven into the ground it is expected that the lower bulkhead 29 of the expendable pile 27 will fail, allowing sand and mud to fill the pile up to the upper bulkhead 28. Water will flow into the space above this bulkhead through the drain holes 31 located just below the driving ring 30. The water rising will however close the float valve 43 in the lowest retractable pile section 33 preventing ingress of water and preserving the buoyancy of this section. By these arrangements the pendant piling while hanging on the crane will be practically self supporting and will remain so until released and power driving starts. At that time the expendable section will lose its buoyancy, but will naturally gain the support of the soil. The free standing sections of retractable piling will retain their buoyancy unless it becomes desirable to load them to assist driving, in which case as much water as may be desired for this purpose can be introduced by simply flooding the piling from above. Water will pour from one section to the next. All of the piling or a portion thereof can thus be filled.

During all this operation the whole weight has been supported by the buoyancy of the pontoon member of the barge and ample stability has been provided at all times. The whole structure, however, being buoyant, will have vertical motion along the piles as a result of wave action. When all the piles are driven the weight of the upper and lower decks and the superstructure is transferred to the piling by fastening the platforms to the piles.

This is accomplished in the following manner. The upper end of each telescoping tube 11 extends above the upper deck 3 and is open at the top into which the piling sections are inserted. When the piles are driven the upper retractable piling section has its top end portion which is open extending above the top of the telescopic tube 11. A lifting cap 51 having a tubular portion 52 which is reinforced at its lower end by means of a ring 53 is seated in the upper end of the retractable piling section 33 to engage the driving ring 34. The lifting cap 51 is provided with latches 54 adapted to snap over the driving ring 34 and flat bars 55 for the latches which are arranged essentially similar to the means for securing the piling sections together. The lifting cap at its upper end is provided with two cross beams 56 having top and bottom cover plates 57 and 58, centrally disposed connecting plates 59 and a lifting eyebolt 60. The two cross beams 56 have their ends extending laterally beyond the sides of the piling and are provided with holes 61 adapted to register with spaced holes 62 in T-shaped lifting bars 63 for receiving pins 64 for connecting them together.

A yoke 65 is mounted for sliding movement on the upper end of the telescoping tube 11. This yoke is provided with ears 66 having holes 67 adapted to register with holes 62 in the T-shaped lifting bars to receive pins 68 for connecting these members together. The yoke is also provided with spaced ears 69 having holes 70 for receiving pins 71 for connecting the upper ends of piston rods 72, the lower ends of which are provided with pistons 73 working in hydraulic transfer cylinders 74 which are rigidly secured to the upper telescoping tube 11 and the superstructure. These hydraulic transfer cylinders 74 are controlled by a four way valve 75 mounted on the lower deck 4.

The final object is to support the upper and lower decks 3 and 4 and the superstructure on the piling through the lifting cap 51, T-bars 63, yoke 65, and the hydraulic transfer cylinders 74 which are an integral part of the structure.

In this transfer method the movement is taken between

the pistons 73 and the cylinders 74, T-bars 63, yokes 65 and piston rods 72 are connected to the lifting caps 51, which are set in the piles. The top and bottom of the cylinders are connected to each other to allow the fluid to pass from one to the other as the structure moves the cylinders, the pistons being held stationary by their connections to the piles. When all are set, the valves between the ends of the cylinder are closed, thereby trapping the fluid in the cylinders and stopping the motion. This can be made a gradual operation, if there is excessive movement of the structure, by closing the valves slowly. This stops the motion and leaves the cylinders ready to take the weight of the structure. The cylinders may be connected to a high pressure manifold having valves for individual adjustment.

Up to this point the pontoon member of the barge is still supporting the major part of the load. The only load on the piles is that exerted by the structure to compensate for a change in the buoyancy of the pontoon member as the swells rise and fall. Due to the incompressibility of the hydraulic fluid, the structure is held in one position while the pressure varies with the change in buoyancy. As the ballast tanks 14 in the pontoon member are being filled, the pressure will increase until all the load is taken by the piling. The structure will then remain stationary. Additional filling of the ballast tanks beyond this point tends to submerge the pontoon member.

An additional means is necessary to prevent a swell from lifting the pontoon member high enough to hit the superstructure after it has begun to submerge. To overcome the change in buoyancy after the ballast tanks 14 of the pontoon member have been filled enough to leave the structure, I use for this purpose hydraulic rams 17 as shown more clearly in Fig. 24. By the use of these rams in sinking it, positive buoyancy can always be maintained in the pontoon of the barge. It will be raised by a process which is essentially the reverse of that described in column 6 line 58 to column 7 line 37, when the ballast tanks are emptied by allowing the force of buoyancy to force the fluid out of the rams through a suitable throttling valve which affords control.

Assuming now that after a period of several months it becomes necessary to remove the piling, the operations would be as follows. The structure is first detached from the piling support and the lifting cap 51, T-shaped lifting bars 63 and yoke 65 are removed. Compressed air is then forced into top of the piling through air valve 48 provided for that purpose. This air will open float valves 43 in the retractable pile sections 33, forcing water and silt out of the drain holes 31. This will make the piling buoyant and will relieve the crane of any dead weight of the string of sections.

The crane now applies lift to the top section, transmitting tension through the successive latches 38. Since each section has buoyancy which is assisting the crane, it is apparent that the maximum tension will occur at the point where the piling enters the bottom, or at the joint between the expendable and the retractable piling sections 27 and 33 respectively.

The tension in each joint is resisted by the action of the bolts 76 holding the latch blocks to the flat springs 39. When originally making the joint between the expendable and retractable piling, half of these bolts are removed from these particular latches. As a result of the natural maximum concentration of tension as explained above and the removal of half of the shearing strength, the joint at this point is bound to fail. The retractable piling being buoyant will rise in the telescoping tubing 11 and 12 permitting the removal of successive sections in the following manner.

Any air pressure in the section of piling is relieved by opening the air valve. The flush plugs 77 in the forcing holes 78 opposite the latches are removed and the threaded ends of two of the multiple wrenches 49 are inserted in the threaded holes 78 and the latches forced inward until they clear the driving ring 34, at which time the uppermost section of piling can be removed. This operation is repeated if there is a plurality of retractable piling sections in the strings. After removing the retractable piling sections the float valves 43 are then closed manually and the piling sections placed in the water where it will float until ready to be used again. The expendable pile 27 will remain in the ground.

Referring now to Figs. 9, 10, 11 and 12, which illustrate diagrammatically the different positions the barge will assume.

The entire apparatus is towed to the proposed drilling location in a floating condition which is diagrammatically indicated in Fig. 9. It is understood that in all the diagrams of conditions indicated that only one pair of telescopic tubing and one hydraulic ram is shown. Actually there are a number of these and this diagram would apply to all. When the equipment has reached the proposed site as indicated in Fig. 9, the expendable and retractable piling sections can be driven through as many of the telescopic tubes as may be desired. If sufficient bearing is developed in the soil of the bottom of the Gulf, the superstructure can be supported on eight piles. Fourteen piles have been indicated in Figs. 1 and 2, and sixteen in Fig. 8, to take care of less substantial soil conditions and to provide transverse strength to resist wind and waves. In this condition the whole apparatus will have sufficient stability and freeboard to perform satisfactorily as a piece of floating equipment. The driving of the piles through the telescopic tubes 11 and 12 will limit the horizontal motion of the floating structure, but will in no way prohibit it from raising with the waves or surge. It is obvious that under these conditions there will be some vertical motion of the telescopic tubes along the piling.

In Fig. 10 the equipment has been adjusted to be ready to be secured to the piling, it is assumed the piling has been driven to a depth which will provide the desired bearing and which will leave the upper end of the section of the piling protruding above the deck. The top of this piling obviously will always be less than fifty feet above the upper deck. The lifting links are now raised into position either by unpinning them entirely and lifting them by means of a crane or by lifting them in successive steps with the hydraulic cylinders 74. The lifting links 63 are placed in such a position that the lifting cap 51 can be placed upon them while still remaining above and outside the piling. Under this condition it should be borne in mind that the telescopic tubing and lifting cap will be moving vertically in an erratic manner relatively to the piling. The lifting cap is then lowered into the piling so as to be almost ready to be secured, but not sufficiently introduced into the piling so as to operate the latch mechanism. The yoke 65 is now raised to the upper end of the stroke of the hydraulic cylinders 74, or as near thereto as possible, and pinned to the lifting links. When all this apparatus has been secured it is allowed to drop into the piling causing the latches to take hold of the piling itself. It is obvious that at this point the lifting cap, lifting links, the yoke and the pistons 73, within the hydraulic cylinders 74 and the working platform will partake of the motion relative to the piling. Under this condition the hydraulic fluid in the cylinders is allowed to flow free from the top to bottom. In this condition, shown in Fig. 10, sufficient ballast has been put into the ballast tanks 14 in the pontoon 2 so as to reduce the freeboard to a value which will provide only a reasonable margin of safety against foundering. This lowering of the pontoon 2 into the water also acts to reduce its righting movement and generally will cause it to be less lively in the water due to the smaller amount of surplus buoyancy available. The equipment is now in a condition to transfer the load of the superstructure to the

piling. In order to do this the fluid supply to the top and bottom sections of the hydraulic cylinders are closed off from each other. As this is done slowly, it at first acts as a shock absorber resisting the motion of the superstructure with the waves and finally locks the superstructure to the piling. While this process has been going on, the ballast tanks **14** in the pontoon **2** have been flooded so that it will have sufficient ballast within it to submerge the pontoon. It has, however, not been allowed to submerge but has been retained in its position against the working platform by means of the rams. In other words, the rams **17** replace the amount of buoyancy which would have been necessary to provide a safe freeboard. The pontoon under these conditions will have no buoyancy to rise and fall wit the waves, and can be lowered as a dead weight to its final submerged position by the rams as shown in Fig. 12. These rams when under pressure are designed to exert a total downward force on the pontoon of about 600 tons, which is sufficient to sink the pontoon about two feet deeper than it would normally float due to ballasting alone. This outside force exerted on the pontoon during the sinking and rasing process is intended to nullify the action of waves which would cause the pontoon to rise and fall. This control is felt to be particularly important when the upper end of the lower tubes **12** are close to the lower deck **4**, as at this time any quick vertical movement of the pontoon **2** could result in striking and damaging the lower deck. Travel indicators and a ram control board are used to guide the operator, who may control the rising or sinking of each corner of the pontoon separately by watching the indicators and manipulating the individual valves accordingly. In this manner the pontoon may be kept level at all times.

When it is desired to remove the apparatus the pontoon **2** can be raised into the position shown in Fig. 11, by gradually pumping the ballast in the tanks **14** overboard. The throttling valves for the rams are opened and as the pontoon **2** is raised the force of buoyancy will force the fluid out of the rams through the throttling valves.

In addition to the main operation as just described, the apparatus can also accomplish other operations to substitute for or to assist either the crane or the rams. One of these operations is the pulling of the piling. While normally this operation can best be done by means of a crane, in the event of a casualty to the crane the hydraulic apparatus will provide a substitute. It will be noted that the upper end of the upper telescopic tube which is adapted to engage the ends of a pin **50** which is placed through the pipes **32** and **35** provided for that purpose in the pile. The top of the upper tube will hold this pin **50** during the original placing of the pile when several sections may be pendant, while the crane is placing and securing additional sections in place. In the event that the crane is not in operation, it would be possible to place the lifting cap, links and yoke in place and to move the piling upwards if the whole apparatus is supported by the piles, or by the buoyancy of the barge. The piling which would be pendant, can be supported as just described by pushing the pin **50** through the pipe. Temporary hoisting gear could be arranged to operate from the lifting cap to remove the sections of piling. This operation would be slow and cumbersome, as lifting could only be accomplished in steps the stroke of the piston **73**, but would provide a means of getting away from a location if one of the cranes had been damaged. A second auxiliary use for the hydraulic transfer system would be to attach the links to the fastening provided for that purpose at the top of the lower telescopic tube **12** as indicated at **95** in Fig. 22. These links could be used to assist the rams or to substitute for them in the event of a casualty to the rams. It should be noted that the tension on the rams is equivalent to the buoyancy which is represented by the freeboard maintained in Fig. 11. If it becomes desirable, for any practical reason, to increase this freeboard and thus increase the tension on the rams beyond their capacity, the use of some of the links as an aid to the rams will be very desirable.

A third additional use for the links as attached to the lower telescopic tube **12** would be in the event that the pumping arrangement for removing ballast in the pontoon had failed. The pontoon itself could be lifted to a point where the deck was above water and the ballast could be removed by local pumping from on deck. This would permit repairs to be made and provide a further safeguard against the equipment being stranded due to the failure of any one part of its mechanism.

The hydraulic system for operating the cylinders will be of conventional type providing a high pressure line and a line back to a low pressure sump. Conventional valves for directing the high pressure to the upper or lower part of the cylinders will be connected to the manifold pipe connecting the cylinders on any one pile. The shutoff valve which locks the system should work independently of the hydraulic pressure as supplied by any outside pump. The hydraulic pressure system could be an individual pump arranged to operate each group of cylinders, or could be a general system having a pump and accumulator. The latter system would offer the advantage that by its use pressure in the various cylinders could be equalized to be certain that all piling was supporting equal loads. This could also be done in the case of an individual pumping system by matching gauge pressures. It is apparent that the hydraulic valves for locking the individual sets of cylinders for supplying pressure and discharge connections could be electrically or hydraulically actuated from some remote point providing the possibility of centralized control by one operator. The methods of doing these things are conventional and have been worked out in a number of other applications.

The arrangement shown is for the purpose of drilling oil wells. The design was developed for this purpose primarily, but the method of the invention could be applied to semi-permanent platforms for any other purpose, conceivably for survey or working points, laying pipe lines or cables, observation platforms for collecting meteorological data, radar stations or other purposes. The invention is not restricted to oil drilling, but necessary changes in procedure for utilization of the platforms for other purposes are obvious.

Although I have shown and described my invention in considerable detail, I do not wish to be limited to the exact construction shown and described, but may use such substitutions, modifications or equivalents thereof, as are embraced within the scope of my invention, or as pointed out in the claims.

I claim:

1. A barge mounted on a body of water, comprising a buoyant member and a superstructure mounted thereon and temporarily supported by the buoyant member, hollow piling guide members in telescopic relation with each other connecting the buoyant member with the superstructure, piles mounted in the hollow telescopic guide members adapted to have their lower ends driven into the bed of the body of water, means for submerging the buoyant member in the body of water to an intermediate point on the tubular guide members, yokes, each of said yokes being associated with one of said piles, means to prevent relative vertical movement between said yokes and said piles, and means to gradually arrest relative vertical movement between said yokes and said superstructure.

2. A barge for drilling oil wells or the like located under a body of water, comprising a superstructure having a deck for supporting drilling equipment, a buoyant member for supporting the weight of the superstructure during the transportation of the barge from one drilling location to another and for temporarily supporting the superstructure at the drilling location, a plurality of pairs of tubular telescopic piling guide members connecting

the buoyant member with the superstructure, a pile slidably mounted in each pair of tubular telescopic piling guide members having its lower end driven into the bed of the body of water, a plurality of rams connecting the superstructure with the buoyant member, fluid pressure means for actuating the rams during the lowering and raising of the buoyant member in relation to the superstructure, yokes slidably mounted to said tubular telescopic piling guide members, means to restrict relative vertical movement between said yokes and said piles and means to gradually hydraulically dampen relative vertical movement between said yokes and said superstructure.

3. A barge for drilling oil wells located under a body of water, comprising a superstructure having a deck for supporting drilling equipment, a pontoon member for supporting the weight of the superstructure during the transportation of the barge from one drilling location to another and for temporarily supporting the superstructure at the drilling location, a plurality of first tubular members having their lower portions rigidly secured to the pontoon member and extending upwardly therefrom above the pontoon member, a plurality of second tubular members having their upper portions rigidly secured to the superstructure and extending above the same a short distance and their lower ends extending downwardly therefrom in sliding telescopic relation with said first tubular members, piles mounted in said first and second tubular members having their lower ends driven into the bed of the body of water, yokes slidably mounted to those portions of said second tubular members extending above the superstructure, means to prevent relative vertical movement between said yokes and said piles, means to gradually dampen relative vertical movement between said yokes and said superstructure, and ballast tanks formed in the pontoon member for receiving or exhausting fluid therefrom for lowering or raising the pontoon member in relation to the superstructure.

4. A barge for drilling oil wells located under a body of water comprising a buoyant member supported in said body of water, a superstructure having a deck with drilling equipment thereon mounted above the body of water and temporarily supported by the buoyant member in spaced relation thereto, a plurality of upper and lower tubular telescopic members connecting the superstructure with the buoyant member and forming pile guides, piles mounted in said upper and lower tubular telescopic members, said piles having their lower ends driven into the bed of the body of water, a lifting cap mounted on the upper end of each pile, a yoke mounted for vertical movement on each of the upper tubular telescopic members, lifting bars connecting the lifting cap and yoke together, a pair of transfer cylinders rigidly secured to the upper end portion of each upper tube, a piston working in each transfer cylinder, a piston rod for each piston having its outer end pivotally connected to the yoke, and fluid pressure means for reciprocating the pistons to transfer the weight of the superstructure from the buoyant member to the piles.

5. A barge for drilling oil wells or the like located under a body of water, comprising a superstructure having an upper and lower deck for supporting drilling equipment, a buoyant member for supporting the weight of the superstructure during the transportation of the barge from one location to another, a plurality of lower tubular members having their lower portions rigidly secured to the buoyant member and extending upwardly therefrom, a plurality of upper tubular members rigidly secured to the superstructure and extending downwardly therefrom each in telescopic relation with one of the upwardly extending tubular members of the buoyant member, a pile mounted in each pair of telescopic tubes adapted to have its lower end driven into the bed of the body of water, a lifting cap mounted on the upper end of each pile, a yoke mounted for vertical movement on each of the upper tubes, lifting bars connecting the lifting cap and yoke together, a pair of transfer cylinders rigidly secured adjacent to the upper end portion of each upper tube, a piston working in each transfer cylinder, a piston rod for each piston having its outer end pivotally connected to the yoke, fluid pressure means for reciprocating the pistons to transfer the weight of the superstructure from the buoyant member to the piles, and means for lowering and raising the buoyant member in relation to the superstructure.

6. A barge for drilling oil wells located under a body of water, comprising a buoyant member supported in said body of water, a superstructure having a deck, with drilling equipment mounted thereon disposed above the body of water and temporarily supported by the buoyant member in spaced relation thereto, a plurality of pairs of tubular telescopic members each pair forming a piling guide connecting the buoyant member with the superstructure, piling mounted in the tubular telescopic members having their lower ends driven into the bed of the body of water, a lifting cap mounted on the upper end of each pile, a yoke mounted for vertical movement on the upper end portion of each tubular telescopic member, lifting bars connecting the lifting cap and yoke together, and fluid pressure actuated means pivotally connected to the yoke for transferring the weight of the superstructure from the buoyant member to the piles.

7. A barge for drilling oil wells located under a body of water, comprising a superstructure having a deck for supporting drilling equipment, a buoyant member for supporting the weight of the superstructure during the transportation of the barge from one drilling location to another and for temporarily supporting the superstructure at the drilling location, first tubular piling guide members having their lower portions rigidly secured to the buoyant member and extending upwardly therefrom, second tubular piling guide members having their upper portions rigidly secured to the superstructure and extending downwardly therefrom in sliding telescoping relation with said first tubular piling guide members, a pile mounted in each pair of telescopic guides having its lower end driven into the bed of the body of water, a lifting cap mounted on the upper end of each pile, a yoke mounted for vertical movement on the upper end porton of each second tubular telescopic member, T-shaped lifting bars pivotally attached for adjustment to the lifting cap and yoke for connecting them together, cylinders attached to the superstructure, pistons working in the cylinders having piston rods pivotally attached to the yoke, and means for controlling the fluid pressure to the cylinders to transfer the weight of the superstructure from the buoyant member to the piles.

8. A barge for drilling oil wells located under a body of water, comprising a superstructure having an upper and lower deck for supporting drilling equipment, a buoyant member for supporting the weight of the superstructure during the transportation of the barge from one location to another, a plurality of lower tubular members having their lower portions rigidly secured to the buoyant member and extending upwardly therefrom, a plurality of upper tubular members rigidly secured to the superstructure and extending downwardly therefrom each in telescopic relation with one of the upwardly extending tubular members of the buoyant member, a tubular pile mounted in each pair of telescopic tubes having its lower end driven into the bed of the body of water, a driving ring in each of the tubular piles near its upper end, a lifting cap having an extending sleeve portion inserted in the upper end of each pile, latches secured to and extending from the sleeve portion of each lifting cap for engaging the driving ring in each pile to secure the lifting cap in place, a yoke mounted for vertical movement on each of the upper tubes, lifting bars connecting the lifting cap and yoke together, a pair of transfer cylinders rigidly secured adjacent to the upper end portion of each upper tube, a piston working in each transfer cylinder, a piston

rod for each piston having its outer end pivotally connected to the yoke, and fluid pressure means for reciprocating the pistons to transfer the weight of the superstructure from the buoyant member to the piles.

9. In combination, a barge, a platform, first members supporting the platform upon the barge, second members, hydraulic damping means associated with the platform to transfer the weight of the platform to said second members, means to remove from supporting relation with said platform said first members, and means for submerging the barge.

10. In combination, a structure adapted to float in a body of liquid, a platform, first means to support said platform in spaced relation to said structure at a substantial distance above the level of said liquid, second means extending to the bottom of the body of liquid to support the platform in substantially the same position as that in which it is supported by said structure, hydraulic damping means operatively interposed between said second means and said platform, means to render said first means ineffective, and means to submerge said structure below the level of the liquid.

11. In a marine structure, the combination of a barge, a plurality of columns carried by said barge, a platform, means supporting the platform on the barge, piles adapted to be lowered through said columns into contact with a marine bottom, means to dampen and restrict relative vertical movement between said platform and said piles, and means to submerge said barge to a position below the water level.

12. In a marine structure, the combination of a barge, a plurality of columns supported on said barge around the periphery thereof, a platform supported over said columns in vertically variable relationship to said barge, openings extending through said platform, columns and barge to provide access to a marine bottom, a plurality of piles extending through said openings and engaging the marine bottom, whereby to restrain said structure against lateral movement due to wave action while permitting said structure to move vertically with respect to said piles, hydraulic damping means associated with said platform and piles for gradually arresting such vertical movement, means for ballasting said barge to destroy its buoyancy and permit submersion of the barge, and means for maintaining said barge in submerged position.

13. The method of operating a marine structure which comprises supporting a platform over columns carried by a buoyant support, driving piling through said platform, columns and support to restrain lateral motion of said platform and support while permitting vertical motion thereof relative to said piling, slowly damping the vertical motion of said platform with respect to said piling until said vertical motion is stopped while simultaneously adding ballast to said support, thereafter submerging said support, and adding additional ballast to said support to destroy its buoyancy.

14. In a method of stabilizing over a marine bottom, a marine vessel comprising a buoyant support, columns carried by said support and a superstructure removably mounted on said columns, the steps of driving piles through a plurality of openings extending through said superstructure, columns and buoyant support into said marine bottom, damping the relative motion between superstructure and piles to zero while simultaneously ballasting said support to reduce its buoyancy, adding additional ballast to said support to destroy its buoyancy, and lowering said support to a predetermined position below water-level.

15. In a method of stabilizing over a marine bottom, a marine and vessel comprising a buoyant support, columns carried by said support and a superstructure removably mounted on said columns, the steps of driving piles through a plurality of openings and extending through said superstructure columns and buoyant support into said marine bottom, connecting said superstructure to said piles by a hydraulic damping means, operating said damping means to reduce the relative motion between superstructure to piles to zero while simultaneously ballasting said support to reduce its buoyancy, and immediately thereafter forcing the support below the surface of the water through the medium of hydraulic rams located between the superstructure and the support.

16. A barge for drilling oil wells or the like located under a body of water, comprising a superstructure having upper and lower decks for supporting drilling equipment, a buoyant member for supporting the weight of the superstructure during the transportation of the barge from one locality to another, first tubular piling guide members having their lower portions rigidly secured to the buoyant member and extending upwardly therefrom, second tubular piling guide members having their upper portions rigidly secured to the superstructure, piles mounted in said first and second tubular piling guide members having their lower ends driven into the bed of the body of water, yokes slidably mounted to said second tubular piling guide members, means to prevent relative vertical movement between said yokes and said piles, means to gradually hydraulically dampen relative vertical movement between said yokes and said superstructure, and means to raise and lower the buoyant member in relation to the superstructure.

17. In a marine structure, the combination of a floating vessel with vertical openings established therethrough to provide access to a marine bottom, a plurality of piles engaging the marine bottom and extending above the level of the vessel, each of said piles being positioned in one of said vertical openings, and a plurality of damping means to dampen the vertical motion of the vessel with respect to the piles due to wave action, each of said damping means being associated with one of said piles, and each damping means comprising a pair of hydraulic cylinders secured to said vessel adjacent said pile, a piston in each hydraulic cylinder, a cap affixed to the top of said pile, members depending from said cap, a pair of piston rods, each of said piston rods connecting one of said pistons with one of said members, hydraulic fluid in said hydraulic cylinders, and means to gradually throttle the flow of said hydraulic fluid in said hydraulic cylinders to dampen vertical movement of said pistons in said hydraulic cylinders, whereby the vertical motion of said vessel with respect to said pile may be gradually arrested.

18. The method of operating a marine structure which comprises supporting a working platform on a buoyant support, floating said buoyant support to a drilling site, driving piling through said platform and buoyant support, gradually damping relative vertical movement between said platform and said piling until said relative vertical movement is entirely arrested and the platform is secured to the piles, and submerging said support to a position below water level.

19. A marine structure comprising a buoyant member, a framework mounted on said buoyant member, a platform surmounting said framework, first pile guides mounted on said buoyant member, second pile guides mounted on said platform in vertical alignment with said first pile guides, piles extending through said first and second pile guides and engaging a marine floor, means for securing said platform to said piles, means for varying the buoyancy of said buoyant member, and means operatively connecting said buoyant member to said platform for submerging and raising said buoyant member relative to said platform.

20. A drilling barge for operating in a body of water overlying a marine floor, said drilling barge comprising a submersible hull with vertical openings formed therethrough, a plurality of tubular members surmounting said hull, each of said tubular members being in registering relationship with one of said openings, a platform surmounting said tubular members, said platform being in vertically variable relationship with said hull, a plurality

of piles, each of said piles being positioned in one of said tubular members, means to dampen and restrict relative vertical movement between said platform and said piles, and means to submerge said hull.

21. A drilling barge for operating in a body of water overlying a marine floor, said drilling barge comprising a submersible hull with first vertical openings formed therethrough, a plurality of tubular members surmounting said hull, each of said tubular members being in registering relationship with one of said openings, a platform surmounting said tubular members, said platform being in vertically variable relationship with said hull, said platform further being formed with second vertical openings, each of said second vertical openings being in registering relationship with one of said tubular members, a plurality of piles, each of said piles being positioned in one of said tubular members and first and second openings, said piles having their lower ends embedded in the marine floor, securing means to dampen and arrest relative vertical movement between said platform and said piles, and means to submerge said hull.

22. A drilling barge as in claim 21, said securing means comprising a plurality of yokes, each of said yokes being arranged adjacent one of said piles, a plurality of means to prevent relative vertical movement between said yokes and said piles, each of said means being operatively interposed between one of said yokes and the pile adjacent said yoke, and a plurality of damping means to gradually restrict relative vertical movement between said yokes and said platform, each of said damping means being operatively interposed between one of said yokes and said platform.

23. A drilling barge for operating in a body of water overlying a marine floor, said drilling barge comprising a hull, a plurality of first tubular members extending through and above and secured to said hull, an operating platform surmounting said first tubular members in vertically variable relationship with said hull, a plurality of second tubular members extending through and secured to said operating platform, each of said second tubular members being in registering relationship with one of said first tubular members, a plurality of piles having their lower ends embedded in the marine floor, each of said piles being positioned in one of said first and second tubular members, a plurality of securing means to dampen and arrest relative vertical movement between said piles and said platform, each of said securing means being operatively interposed between said platform and one of said piles, and submerging means to submerge said hull.

24. A drilling barge as in claim 23, said drilling barge further including ballast compartments in said hull, said submerging means comprising ballasting means to introduce ballast into said ballast compartments, venting means to vent said ballast compartments, and ram means operating against the weight of the platform to push down said hull.

25. A drilling barge as in claim 23, said drilling barge further including ballast compartments in said hull, said submerging means comprising ballasting means to introduce ballast into said ballast compartments, venting means to vent said ballast compartments, and ram means operating against the weight of the operating platform and the skin friction of the piles in the marine floor to push down said hull.

26. A drilling barge as in claim 23, said securing means comprising a yoke arranged adjacent one of said piles, means to prevent relative vertical movement between said yoke and said pile, and damping means to secure said yoke to said platform.

27. A drilling barge as in claim 23, said securing means comprising a yoke slidably mounted on one of said second tubular members, means to prevent relative vertical movement between said yoke and said pile, and damping means to secure said yoke to said platform.

28. A drilling barge as in claim 27, said damping means comprising a pair of hydraulic cylinders adjacent said yoke and in vertically invariable relationship to said platform, a piston in each hydraulic cylinder, a piston rod connected at one end to the piston and at the other end to the yoke, hydraulic fluid in said hydraulic cylinders, and valve means to throttle the flow of hydraulic fluid in said hydraulic cylinders.

29. A drilling barge as in claim 27, said damping means comprising a pair of hydraulic cylinders adjacent said yoke and in vertically invariable relationship to said platform, a piston in each hydraulic cylinder, a piston rod connected at one end to said piston and at the other end to said yoke, hydraulic fluid in said hydraulic cylinders, piping means communicating from the tops of said hydraulic cylinders to the bottoms of said hydraulic cylinders, and valve means in said piping means to throttle the flow of hydraulic fluid.

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