Aug. 27, 1963 W. G. WILSON ETAL 3,101,798

MARINE DRILLING APPARATUS

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Fig. 1

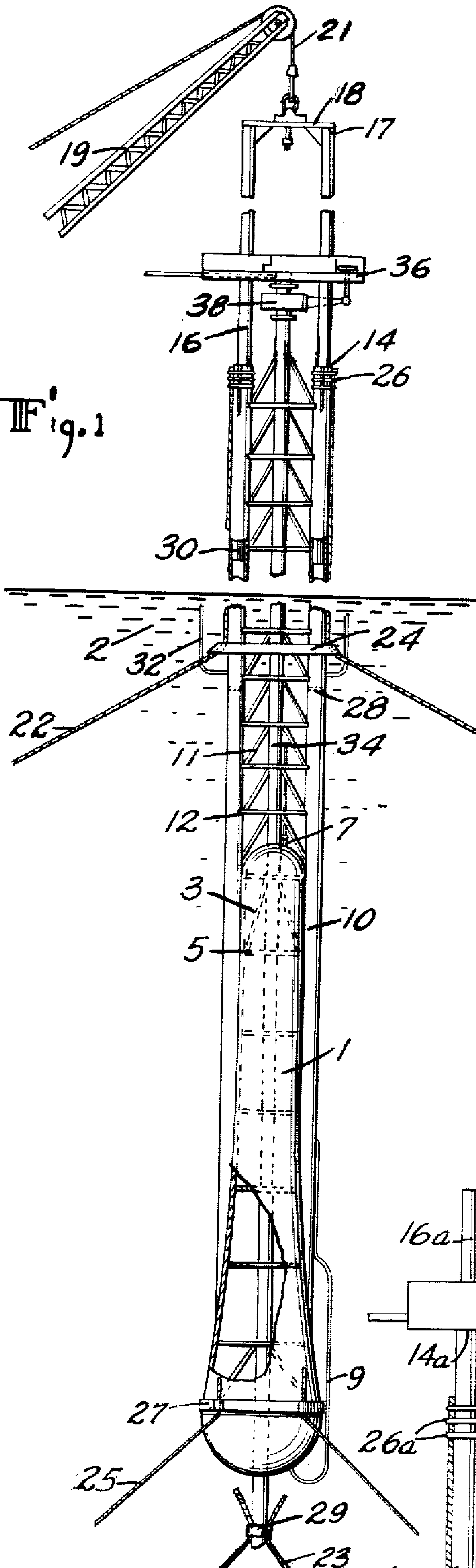

Fig. 3

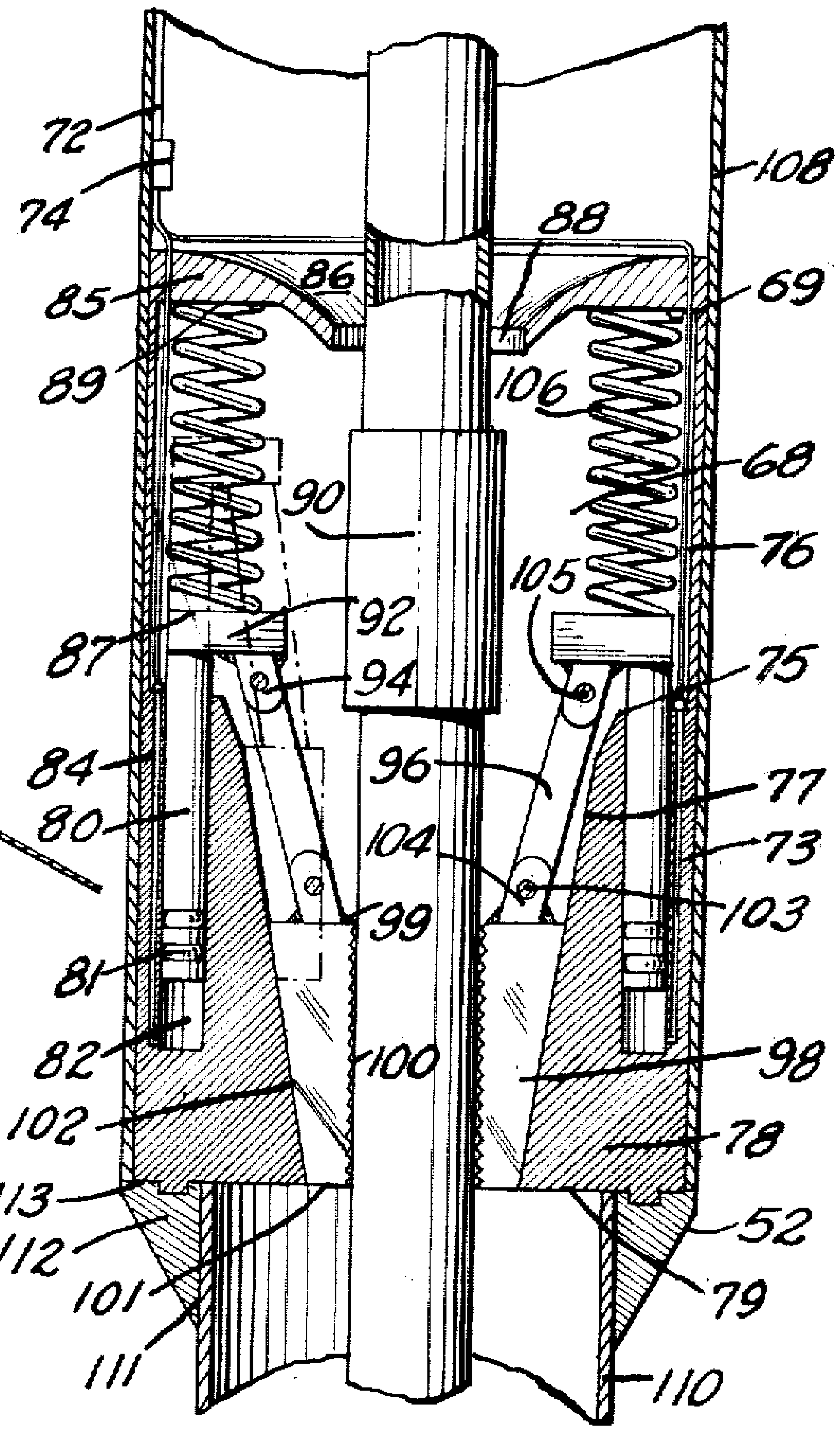

Fig. 4

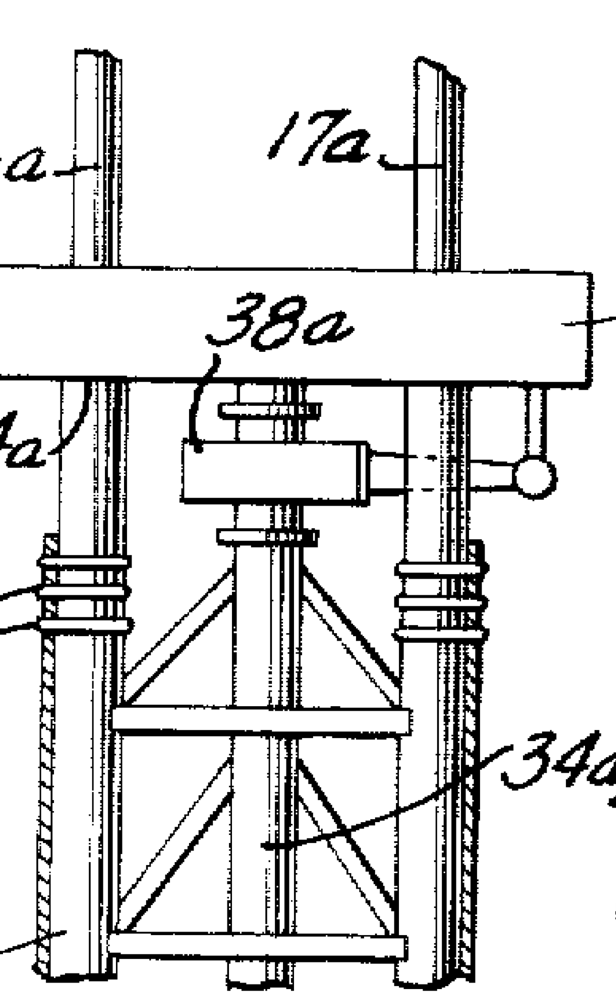

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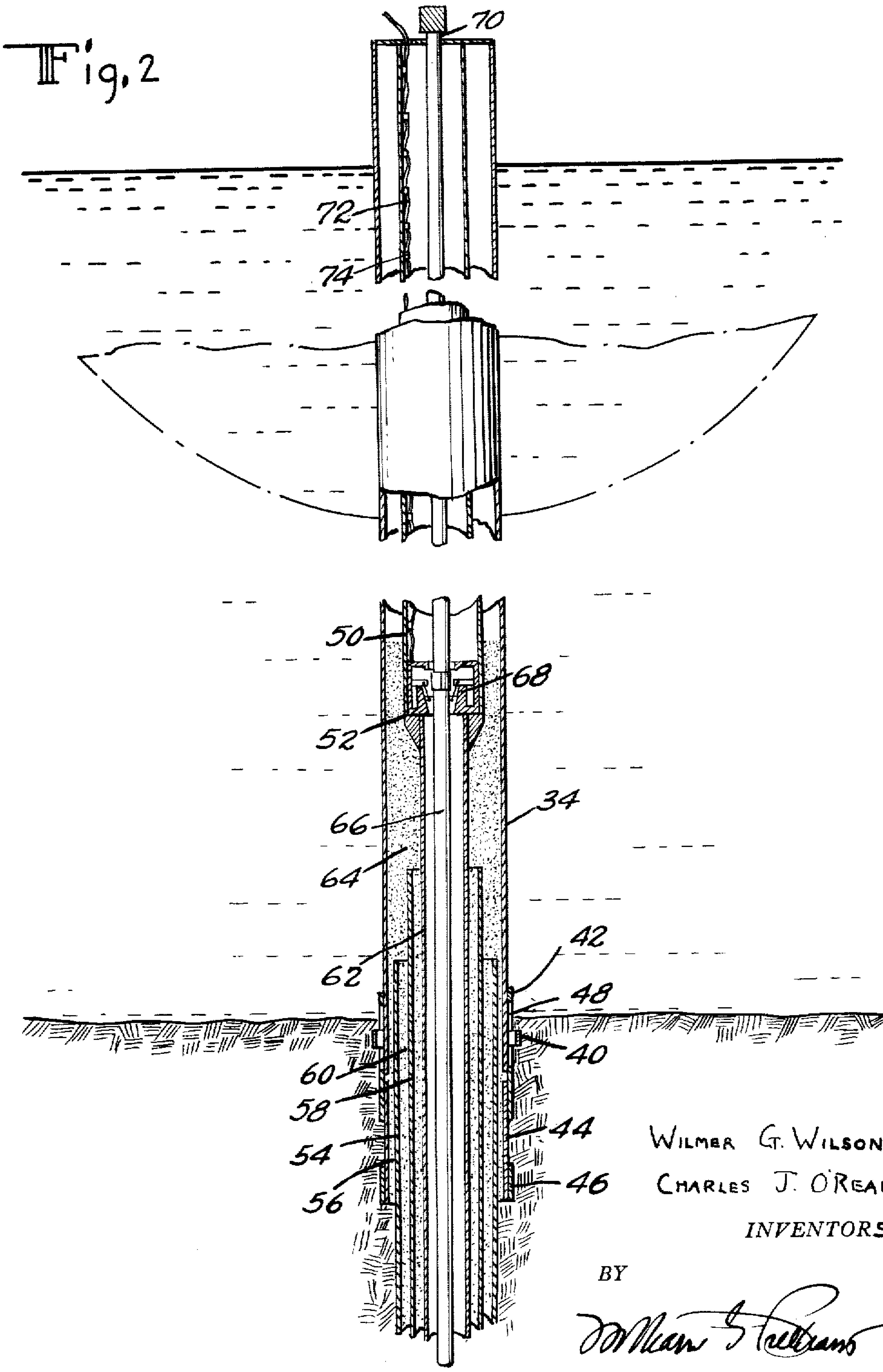
Fig. 2



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MARINE DRILLING APPARATUS

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4 Claims. (Cl. 175—8)

This invention relates to apparatus for drilling a well under a body of water and more particularly to a device for the drilling of offshore oil wells. Many of the devices for drilling under water which have proved relatively successful in shallow water are not adaptable to offshore drilling in deeper water. The use of submersible drilling barges and permanent platforms or pilings cannot be used economically in deep water as the construction costs of such devices increase prohibitively as the depth of the water increases.

Other devices, such as floating barges or vessels which support the entire drilling operation have such limited stability that the wind and wave forces incident to only moderately bad weather would cause operations to be suspended while severe weather would necessitate closing off of the well, removal of the equipment and removal of the vessel to a safer place. Difficulty is experienced in closing off the well during this interruption. Also, there is sometimes difficulty in locating the drilling sight on return. The principal difficulty with such devices is withdrawing drilling or other equipment from the well and subsequently re-entering the well with such equipment.

Accordingly it is an object of this invention to provide a marine well drilling apparatus that may be employed in relatively deep water. Another object of this invention is to provide a marine well drilling apparatus that is mobile, economical to construct and one whose cost does not increase materially as the depth of the water increases.

It is a further object of this invention to provide a marine well drilling apparatus that insures greater stability against movement due to the wind and wave forces even under the most severe conditions.

It is still a further object of this invention to provide a marine well drilling apparatus that does not require complete removal of equipment for temporary suspension of drilling operations.

Briefly our invention contemplates a well conductor which penetrates the marine floor and extends above the surface of the water. Within the well conductor, a down the hole shoulder is placed on which a tubing hanger is positioned. A buoyancy vessel is attached to the well conductor to support it and is stabilized by anchorage cables attached to the vessel. A system of tubular members into which pistons are inserted is attached to the buoyancy vessel. The drill string is supported by the pistons and the pressure on the drill bit is controlled by the vertical movement of the pistons.

These and other aspects of this invention may be more completely understood in the light of the following detailed description taken in conjunction with the accompanying drawings in which:

FIGURE 1 is a side elevation partly broken away illustrating the buoyancy vessel, tubular members and pistons.

FIGURE 2 is a side elevation partly broken away illustrating the well conductor, casings and drill pipe with vessel, tubular members and pistons removed.

FIGURE 3 is a side elevation broken away illustrating the tubing hanger and down the hole shoulder.

FIGURE 4 is a partial side elevation similar to FIG-3. The arrangement of apparatus shown in FIGURE 4 is similar to that shown in FIGURE 3 except as noted below.

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Referring to FIGURE 1, buoyancy vessel **1** is a chambered vessel of controllable buoyancy which is submerged beneath the surface of the water **2**. The configuration of vessel **1** is not to be limited to the one shown here but may be of any configuration suitable to withstand the collapsing pressure due to the external hydraulic head, which may vary depending on the wave height and position, and the bursting pressure due to the internal pressure in the vessel which is constant. Vessel **1** is braced interiorly by diagonal braces **3** and horizontal struts **5**. The proper buoyancy in vessel **1** for support of the drilling apparatus is maintained by controls on the surface, which introduce or remove water through water fill and drain line **9**, and gas through gas fill and bleeder line **7** thus maintaining the proper net weight of the vessel and its contents. Any gas may be used to maintain the proper buoyancy in vessel **1**. In the preferred embodiment of this invention, a mixture of butane and propane is used because the vapor pressure of the mixture may be designed to yield the exact pressure needed to balance the opposing collapsing and bursting pressure forces. In addition, the mixture could be handled as a liquid at relatively low pressures thus requiring smaller equipment than would be required to compress air or other gases.

Attached to and supported by vessel **1** are a plurality of vertical, longitudinal tubular members **10** which are spaced in symmetrical relationship to each other and connected by diagonal bracing **11** and horizontal struts **12**. Tubular members **10** are attached to vessel **1**. In the preferred embodiment of this invention members **10** are attached to vessel **1** for substantially the entire length of the vessel. However, it is only necessary that members **10** be sufficiently attached to vessel **1** to provide adequate support for the tubular members. At the upper end of tubular members **10** is a fluid and gas tight seal **14** which prevents any loss of gas or fluid when pistons **16** are inserted telescopically into members **10**. Any seal that will prevent loss of gas or fluid under pressure may be used. An opposed pair of tubular members are illustrated in the drawings, but it should be understood that any suitable number such as four or more may be used.

Pistons **16** are placed within the upper ends of tubular members **10** and are joined at their upper ends **17** by crosshead **18**. Crosshead **18** may be of any design that will maintain pistons **16** in their proper vertical relationship. Crosshead **18** joins pistons **16** so that they operate as a single unit.

Anchorage cables **22**, **23** and **25** are secured to the marine floor by an conventional means. Cables **22** extend from the marine floor through guide **24** positioned on tubular members **10** and extending to the top of members **10** where they are secured by clamps **26**. Cables **25** extend from the marine floor through guide **27** positioned on vessel **1** to the top of members **10** where they are secured by clamps **26**. Any method of securing cables **22** and **25** may be used. In addition to anchoring the drilling apparatus cables **22** and **25** serve to resist the torque forces generated by the rotary drilling operations if such is the method used. Cables **23** extend from the marine floor to well conductor **34** through guide **29**, positioned on conductor **34** to the top of members **10** where they are secured by clamps **26**. Cables **23** dampen any vibrations which might otherwise become a serious problem whenever the period or frequency of the waves coincides with the natural frequency of the conductor **34** which may vary from time to time depending on the load on the system. The lower conductor is always under tension, rather than compression, due to the buoyancy of the vessel. One vibration dampening cable is illustrated but more than one cable may be used if desired or conditions require it.

Hydraulic or gas pressure means are provided for raising or lowering pistons **16**. This may be accomplished by any conventional pressure means. In the preferred embodiment of this invention a dam **28** is placed in the lower portion of members **10** to define a fluid or gas chamber **30** within each member **10** above the location of dam **28**. Hydraulic fluid or gas underpressure is injected into or removed from chamber **30** by way of lines **32** which extend from chamber **30** to a pressure fluid or gas control source maintained on the drilling tender.

Well conductor pipe **34** is rigidly attached to and passes through vessel **1** and the diagonal bracing **11** and horizontal struts **12** of members **10**. Pipe **34** extends from a short distance below the marine floor to above the surface of the water. Pipe **34** terminates at its upper end in means for the installation of conventional drilling equipment. One well conductor is illustrated as a preferred embodiment of this invention, but more than one conductor may be used for the drilling of multiple wells. Changes in the vessel and other equipment would have to be made to accommodate the additional conductors. No showing has been made of drilling equipment to be placed on the drilling platform because selection of such is left to the operator. Under normal conditions it would include a rotary table with light hydraulic or electric prime mover and transmission, swivel, control valves, pneumatic pipe tongs and a hoist. All other equipment except connecting pressure and mud lines and electric power cables if needed would be supported by a barge anchored adjacent to the improved drilling apparatus of this invention. The blow-out preventer **38** is positioned on pipe **34** a short distance below its upper end. Drilling platform **36*a*** may be positioned on members **10*a*** at the upper end of members **10*a*** as shown in FIGURE 4.

Referring to FIGURE 2, well conductor pipe **34** may be any conventional conductor pipe. Pipe **34** extends above the surface of the water to below the marine floor. Keys **40** are attached at the lower end of pipe 34. Sleeve **42** is slotted at positions **48** which correspond to the position of keys **40** in order that sleeve **42** may be held in vertical sliding relationship to the exterior of pipe **34**. Section **44** of conductor pipe with diameter equal to pipe **34** is attached to the lower end of the interior of sleeve **42**. Drive shoe **46** is attached to the lower end of pipe **44**.

Upper outer well casting **50** is positioned within pipe **34** and extends from above the surface of water **2** to the down the hole shoulder **52**. Lower well casing **54** extends from within the lower end of pipe **34** above sleeve **42** into the formation. Casing **54** is cemented to the formation and to pipe **34** by cement **56**. An intermediate string of well casing **58** is positioned within casing **54** extending from above the upper end of casing **54** into the formation. Casing **58** is cemented to conductor **34**, casing **54** and the formation by cement **60**. Additional intermediate strings of well casing may be used if needed. Well casing **62** is positioned within casing **58** and extends from the down the hole shoulder **52** into the earth formation to the drilling zone or to the production zone after drilling has been completed. Casing **62** is cemented to the formation, casing **58** and pipe **34** by cement **64**. The depth of penetration of the well casings into the formation will vary according to the nature of the formation and depth of drilling operations.

Drill pipe **66** is positioned within well casings **50** and **62** with sufficent length to extend from above the surface into the earth formation to the drilling zone. Pipe **66** terminates at its upper end **70** in means for the installation of conventional well drilling equipment.

Down the hole shoulder **52** is positioned between casing **50** and **62** and supports tubing hanger **68**. The shoulder **52** and hanger **68** are more fully described in reference to FIGURE 3. Tubing hanger **68** is supplied with hydraulic pressure by way of lines **72** which extend from the hanger to the hydraulic pumps maintained on the drilling tender. Line **72** is held in contact with the inner wall of string **50** by magnets **74** or other means as desired.

Referring now to FIGURE 3, a tubing hanger generally indicated by the numeral **68** is positioned within casing **50** on down the hole shoulder **52**. Hanger **68** comprises a body portion **69** having side walls **76** which are elongated and curved to fit the interior of casing **50**. The length and size of side wall **76** varies in accordance with the size of pipe to be supported and the interior diameter of casing **50**. The lower end of side wall **76** terminates in a wedge-shaped member **78**. The lower end of wedge-shaped member **78** terminates in a flat surface **79**, which will rest against shoulder **52** when the hanger is assembled and placed in casing **50**. The innermost side **77** of wedge-shaped member **78** slopes downwardly toward the interior of hanger **68**. The outermost side **73** of member **78** is curved to fit the interior of sidewalls **76**. Sufficient space is left at the bottom of side **77** to permit pipe couplings **90** and conventional pipe protectors to pass freely through hanger **68**. The upper end **75** of member **78** includes a plurality of piston receiving cylinders **82**. Wedge-shaped member **78** has been described as integral with side wall **76**. While this arrangement is the preferred embodiment, member **78** may be fashioned separately and firmly affixed to side wall **76** by welding or other means. Members **78** may be fashioned so as to extend completely around the interior of side walls **76** or they may be fashioned as individual sections and spaced around the interior of side walls **76**.

Cylinders **82** are of sufficient length and diameter to permit vertical movement of pistons **80**. A plurality of pistons **80** are provided each for insertion into one of cylinders **82**. Pistons **80** are cylindrical bodies having piston rings **81** attached to their lower ends. Rings **81** provide a fluid tight seal to prevent the escape of hydraulic fluid introduced into the cylinders **82** below pistons **80** by way of passageway **84**. Passageway **84** extends downwardly from the top **75** of wedge-shaped member **78** to the lower end of cylinders **82** and below the lower end of pistons **80**.

The upper end **85** of hanger **68** has a sloping surface **86** having a hole **88** positioned in the center thereof. The diameter of hole **88** is sufficient to permit free passage of pipe protectors, drill pipe **66** and couplings **90**. Hole **88** may be threaded to permit lowering or removal of hanger **68**. Hydraulic lines **72** pass through the upper end **85** and are connected to passageways **84** to permit free passage of hydraulic fluid to pistons **80**.

A flat elongated spring receiving member **92** is attached to the upper end of each piston **80**. Positioned on the upper flat surface **87** of member **92** is a spring **106**. Spring **106** is positioned between surface **87** and the underside **89** of the top **85** of hanger **68**.

Ears **94** are affixed to the side or underside of spring receiving members **92**. Links **96** are connected at their upper end pivotally to ears **94** by bolts **105**. Links **96** are connected at their lower end pivotally to ears **104** by bolts **103**. Ears **104** are affixed to the upper end of top of jaws **98**. Ears **94** and **104** may be affixed to members **92** and jaws **98** connected to links **96** any conventional means. One side **102** of jaws **98** slopes inwardly and downwardly from its upper end **99**. Side **102** corresponds in angle of slope and configuration to the sloping side **77** of wedge-shaped member **78**. The opposite side **100** is separate or of other suitable configuration to enable jaws **98** to grip and hold pipe **66** when placed adjacent thereto. Remaining sides of jaws **98** may be of any suitable configuration. The lower end **101** of jaws **98** is flat and of a width sufficient to be wedged between member **78** and pipe 66 when jaws 98 are forced down side 77 of member 78 by the expanding action of spring 106. The remote-controlled, removable hanger, described above, is merely one embodiment of a pipe hanger. Any other arrangement, such as the pipe hanger described in our copending application, Serial Number 719,041, filed March 4, 1958, which will engage and support pipe loads when desired, will be satisfactory. Hangers of the tubing catcher type which would engage the internal surface of the casing could be substituted for the hanger illustrated in this invention. The use of such a hanger would eliminate the need for the down the hole shoulder.

Down the hole shoulder generally indicated by the numeral 52 comprises two body section 108 and 110. Body section 108 is a short elongated section of conventional well casing corresponding to diameter to well casing 50 and is connected to it by a conventional well coupling. Body section 110 is a short elongated section of conventional well casing of less diameter than section 108 and corresponding in diameter to well casing 62. Section 110 is connected to casing 62 by a conventional well coupling. Sections 108 and 110 are joined together by wedge-shaped member 112. Member 112 has a curved side 111 of a curvature corresponding to the curvature of section 110 which side is firmly affixed to section 110 by welding or other means. Member 112 has a flat upper surface 113 to which section 108 is affixed by welding or other means. Wedge-shaped members 78 of hanger 68 rest on surface 113 when the hanger is assembled and installed in the well casing. While the above is the preferred embodiment of shoulder 52 this invention should not be limited to it. For example it is possible to fashion the shoulder as an integral part of that section of well casing joining casings 50 and 62, member 112 may be utilized to join conventional sections of well casing or shoulder 52 may be fashioned of one piece of material.

Prior to installation at a drilling site, well conductor pipe 34 with vessel 1, tubular members 10, bracing 11 and struts 12 are assembled in a shipyard. Sleeve 42 is inserted over the lower end of pipe 34 and keys 40 are installed. Floats are attached, or the ends of the conductor are capped, after which the system is then floated to the drilling site. Cables 22, 23 and 25 are anchored to the ocean floor and threaded through guides 24, 29 and 27 respectively and secured to clamps 26 leaving plenty of slack on the cable.

Vessel 1 is filled with gas or compressed air through line 7. The lower end of conductor 34 is lowered until the conductor is in a vertical position. At this stage the vessel and conductor are floating in a vertical manner and over the desired location with most of vessel 1, the upper part of members 10 and pipe 34 out of the water. Slack from cables 22, 23 and 25 is taken up and they are secured to clamps 26. The drilling tender or barge on which most of the drilling equipment is maintained is securely anchored adjacent to the upper end of pipe 34. Vessel 1 is then flooded to the point wherein it is adequate to maintain the system in vertical position yet maintain negative buoyancy to the vessel.

Vessel 1 and conductor 34 are lowered until the lower end of conductor 34 penetrates the marine floor to refusal or to the desired distance. If this penetration is insufficient the vessel and conductor are raised a distance equal to or less than the length of slots 48. The drive shoe 46, conductor pipe section 44 and sleeve 42 remain in place. The vessel and conductor are then lowered rapidly to drive shoe 46 deeper into the formation. This operation is repeated until the desired penetration is achieved. Slack is again taken up on cables 22, 23 and 25, and they are secured to clamps 26. Sufficient water is now removed from the chamber to establish the desired system net buoyancy. Cables 22 and 25 will now restrain within acceptable limits any horizontal oscillatory movement generated by the waves, that is, 3 to 5 ft. during hurricane conditions and a few inches during operating weather. The buoyancy of the system will offset any downward component of the wave forces and the friction between the driven conductor 34 and the formation into which it is driven will anchor the system and offset any upward component of the wave forces, thus, preventing vertical movement of the system. The vessel and the conductor are at this point entirely stable and secure and can withstand any storm or hurricane.

The use of slip joints and drive shoes is illustrated as a preferred embodiment of this invention in the installation of the conductor in the marine floor. Any other means well known to one skilled in the art may be substituted for this preferred arrangement.

If the formation should be very soft, mud sills could be substituted for the slip joints. The mud sills reacting against even very soft formations would provide the required stability for the system until the casings had been set and cemented. In the opposite extreme, should the marine formation be rocky or extremely hard, stability could be secured by attaching a large shaped concrete weight to the bottom of the conductor which would provide the required stability until casings could be set and cemented. Cables 23 would dampen vibration of the vessel 1 and conductor 34 which would result whenever the period or frequency of the waves coincides with the natural frequency of conductor 34 which results from the drilling operation. Platform 36 is installed on the upper end of pipe 34 or the upper end of members 10 and blow-out preventor 38 is installed either on the upper end of pipe 34 or the upper end of casing 50. All other drilling equipment except the rotary table, swivel, control valves, pneumatic pipe tongs and a hoist is carried by the drilling tender.

Pistons 16 and crosshead 18 are installed on members 10 utilizing a boom 19 and line 21 for this purpose. During drilling operations the crosshead will support a swivel to which is secured a kelly joint and, in turn, the string of drill pipe. Pistons 16 are actuated by gas or liquid under pressure introduced into the lower end of chamber 39 by line 32. The pressure on the pistons is set at a computed value which equals the difference in net weight of drill pipe 66 and the desired bit pressure which is normally twenty or thirty tons. As the bit penetrates the formation, part of the desired bit load transfers to the string of drill pipe and thence through the kelly joint, swivel and crosshead to the pistons. This results in a load on the pistons which is in excess of the opposing force generated by the set hydraulic pressure of the fluid in the cylinders. This unbalance of force will cause fluid to be exhausted from below the pistons in the cylinders thus allowing the entire assembly of piston, crosshead, swivel, kelly drill pipe and drill bit to travel downwardly until the desired bit pressure and force balance is restored. As each section of pipe 66 is added, the pressure on the pistons is adjusted to compensate for the change in load. When running tubing or casing or when coming in or coming out of the hole with drill pipe, the swivel on the crosshead would be replaced by elevators which would be operated in a conventional manner in conjunction with the down the hole hanger.

Casing 54 is installed in the formation and cemented to it and pipe 34 by cement 56. Casing 58 is installed within casing 54 and cemented to the formation, pipe 34 and casing 54 by cement 60. Casing 62 with down the hole shoulder 52 and casing 50 is installed in casing 58. String 62 and shoulder 52 are cemented to the formation, pipe 34 and casing 58 by cement 64. Installation of these casings may be by any method known to those skilled in the art.

Tubing hanger 68 is assembled by inserting pistons 80 in cylinders 82 in wedge-shaped member 78. Links 96 are installed in ears 94 and 104 and secured by bolts 105 and 103 respectively thus connecting jaws 98 and pistons 80. Springs 106 are inserted between spring receiving members 92 and underside 89 of the top 85 of the hanger body. Hydraulic lines **72** are connected to the passageways **84** in order that hydraulic pressure may be supplied to pistons **80**. Hanger **68** is lowered until it rests on shoulder **52**. Line **72** extends to the surface and is held against the inner wall of string **50** by magnets **74**. Hanger **68** is of such construction that it encircles drill pipe **66** but permits free passage of the pipe. Sufficient hydraulic pressure is supplied to pistons **80** to keep them in a raised position thereby permitting free passage of pipe **66** through hanger **68**.

During drilling operations it becomes necessary to add additional lengths of pipe **66**. This may be accomplished by releasing the hydraulic pressure in line **72**. Lack of pressure on pistons **80** permits springs **106** to expand forcing jaws **98** down wedge-shaped members **78** against pipe **66** thereby gripping pipe **66** and preventing its downward movement. The kelly joint, not shown, suspended from the swivel on crosshead **18** is disconnected from pipe **66**. Additional hydraulic fluid is pumped into chamber **30**, thereby raising pistons **16** and crosshead **18** and an additional length of pipe is added. Hydraulic pressure is again supplied through line **72** to pistons **80** forcing them upward and causing spring **106** to contract. This releases jaw **78** and transfers the weight of pipe **66** to pistons **16** and crosshead **18**. Pressure in chamber **30** is adjusted to support pipe **66** and still maintain the desired bit pressure. If pneumatic rather than hydraulic pressure is utilized, the same general procedure will be followed except that it will be necessary to provide braking or snubbing facilities to control the upward movement of the pistons when the main pipe load is lodged on the down the hole shoulder. If desired a light telescoping mast may be positioned on the drilling platform to aid in the handling of the drill pipe. This mast would stabilize the two or three joints of pipe extending above the crosshead thereby permitting removal of the pipe in doubles or triples.

In the event operations are to be interrupted such as for impending bad weather pressure in line **72** is released thereby activating jaws **98** so that they support pipe **66**. Pistons **16** and crosshead **18** are removed and the required light and foghorn installed on the platform **36**. The remaining equipment is of such stability that it is able to withstand the most severe hurricane.

After this shut down the pistons **16** and crosshead **18** may be replaced and jaws **78** returned to the original positions in a very short time, thereby eliminating much of the delay experienced in the present systems when operations are to be resumed after a storm.

From the foregoing it is apparent that the present invention provides a novel well drilling apparatus. The weight of the system rather than being supported by barges or derricks is supported by the buoy and well conductor assembly including a down the hole shoulder and pipe hanger combination capable of supporting great weights during storm conditions, thus eliminating the costly structures used in present systems whose costs increase prohibitively with an increase in depth of the water.

Although we have described our invention with a certain degree of particularity, it is understood that the present disclosure has been made only by way of example and that numerous changes in details and combinations and arrangements of parts may be resorted to without departing from the sphere and scope of this invention as hereinafter claimed.

We claim:

1. Marine drilling apparatus comprising a vessel of controllable buoyancy, means associated with said vessel to control its buoyancy, a plurality of tubular members affixed to said vessel, said members being maintained in vertical and equally distant relationship to each other, said members being of sufficient length to extend above the surface of the water upon the placing of the vessel at the desired position under the water, said members

being closed at their lower ends and open at their upper ends to receive a piston, a plurality of pistons each adapted to be received within the upper end of one of said tubular members in telescopic relationship thereto, said pistons being of sufficient length to permit the attachment or removal of drill string sections when in an extended position, a crosshead rigidly connected to the pistons and adapted to maintain the pistons in vertical fixed relationship to each other and having means attached thereto for supporting a drilling string, pneumatic means associated with the lower section of the tubular members whereby gas may be introduced into or released from said members to raise or lower the pistons, a plurality of anchorage cables being of sufficient length to extend from the marine floor to the upper end of the tubular members, guide means positioned in the lower portion of the submersible vessel, said anchorge cables passing through said guide means; clamping means for securing said anchorage cables to the upper end of the tubular members, said cables being spaced equally distant from each other, a second plurality of anchorage cables extending from the marine floor to the upper end of the tubular members; guide means positioned on the tubular members, said second plurality of anchorage cables passing through said guide means, clamping means for securing said second plurality of anchorage cables to the upper end of the tubular members, said cables being spaced equally distant from each other; a plurality of vibration dampening cables anchored to the marine floor and extending to the upper end of the tubular members, guide means secured to the well conductor below the submersible vessel, said vibration dampening cables passing through said guide means, clamping means for securing said vibration dampening cables to the upper end of the tubular members, at least one vertically positioned well conductor extending from the marine floor through the vessel to above the surface of the water, means to maintain the conductor in parallel fixed relationship to the tubular members and submersible vessel, said conductor terminating at its upper end in means to support drilling equipment, a down the hole shoulder positioned within the well conductor near the marine formation, said shoulder consisting of a body section joining the well casing above and below such shoulder, supporting means integral with the interior of said body section to receive a tubing hanger, said means having at its upper end a flat surface of sufficient width to support a tubing hanger, said means having at its upper end a flat surface of sufficient width to support a tubing hanger, and a tubing hanger positioned on said supporting means.

2. Marine drilling apparatus comprising a submersible vessel of controllable buoyancy, means connected to said vessel for controlling its buoyancy, a plurality of tubular members attached to said vessel so as to be maintained in vertical equally-spaced relationship to each other, said members being of sufficient length to extend above the surface of the water when said vessel is submerged the desired distance below the water level, said members being closed at their lower ends and open at the upper ends to receive a piston, a plurality of pistons each adapted to be received within the upper end of one of said tubular members in telescopic relationship thereto, said pistons being of sufficient length to permit the attachment of drill string sections when the pistons are in a raised position, said pistons terminating at their upper end in means to maintain the pistons in fixed vertical relationship to each other and having means attached thereto for supporting a drilling string, hydraulic means connected to the lower portion of the tubular members to control the vertical movement of the pistons within the tubular members, cables anchored to the marine floor and secured to the tubular members and submersible vessel, at least one vertically positioned well conductor extending from the marine floor through the submersible vessel to above the

surface of the water, means for maintaining said conductor in vertical fixed relationship to the tubular members and vessel, said conductor terminating at its upper end in means for supporting drilling equipment, well casing positioned within said conductor extending from the formation to the upper end of the conductor, a down the hole shoulder positioned within the well conductor near the marine floor joining two sections of well casing, said shoulder consisting of an upper and lower body section, said upper body section joined to the well casing positioned above said shoulder, said lower body section joined to the well casing positioned below said shoulder, said lower body section being of less diameter than the upper body section, said upper body section being joined to the lower body section by supporting means having at its upper end a flat surface adapted to receive a tubing hanger, and a tubing hanger positioned on said supporting means.

3. Marine drilling apparatus comprising a vessel of controllable buoyancy, means associated with said vessel to control its buoyancy, a plurality of tubular members affixed to said vessel, said members being maintained in vertical and equally distant relationship to each other, said members being of sufficient length to extend above the surface of the water upon the placing of the vessel at the desired position under the water, said members being closed at their lower ends and open at their upper ends to receive the piston, a drilling platform attached to the upper end of the tubular members, a plurality of pistons each adapted to be received within the upper end of one said tubular members in telescopic relationship thereto, said pistons being of sufficient length to permit the attachment or removal of drill string sections when in an extended position, a crosshead rigidly connected to the pistons and adapted to maintain the pistons in vertical fixed relationship to each other and having means attached thereto for supporting a drilling string, hydraulic means associated with the lower portion of the tubular members whereby fluid may be introduced into or released from said members to raise or lower the pistons, cables anchored to the marine floor and secured to the tubular members and the vessel, at least one vertically positioned well conductor extending from the marine floor through the vessel to above the surface of the water, means to maintain the conductor in parallel fixed relationship to the tubular members and submersible vessel, a down the hole shoulder positioned within the well conductor near the marine formation, said shoulder consisting of a body section joining the well casing above and below such shoulder, supporting means integral with the interior of said body section to receive a tubing hanger, said means having at its upper end a flat surface of sufficient width to support a tubing hanger, and a tubing hanger positioned on said supporting means.

4. Marine drilling apparatus comprising a vessel of controllable buoyancy, means for controlling the buoyancy of the vessel, a pair of opposed tubular members affixed to said vessel, said members being maintained in vertical and equally distant relationship to each other, said members being of sufficient length to extend above the surface of the water upon the placing of the vessel at the desired position under the water, said members being closed at their lower ends and open at their upper ends to receive the piston, two pistons each adapted to be received within the upper end of one said tubular members in telescopic relationship thereto, said pistons being of sufficient length to permit the attachment or removal of drill string sections when in an extended position, a crosshead rigidly connected to the pistons and adapted to maintain the pistons in vertical fixed relationship to each other and having means attached thereto for supporting a drilling string, hydraulic means associated with the lower portion of the tubular members whereby fluid may be introduced into or released from said members to raise or lower the pistons, cables anchored to the marine floor and secured to the tubular members and the vessel, at least one vertically positioned well conductor extending from the marine floor through the vessel to above the surface of the water, means to maintain the conductor in parallel fixed relationship to the tubular members and submersible vessel, said conductor terminating at its upper end in means to support a drilling platform, a down the hole shoulder positioned within the well conductor near the marine formation, said shoulder consisting of a body section joining the well casing above and below such shoulder, supporting means integral with the interior of said body section to receive a tubing hanger, said means having at its upper end a flat surface of sufficient width to support a tubing hanger, and a tubing hanger positioned on said supporting means said means for controlling the buoyancy of the vessel consisting of a gas fill and bleeder line, a water fill and drain line and means for controlling the introduction or removal of gas or water to obtain the desired buoyancy of the vessel, said gas fill and bleeder line extending from the upper end of the vessel to the drilling platform, said line being adapted to inject water into or remove water from said vessel.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,101,798 August 27, 1963

Wilmer G. Wilson et al.

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 2, line 51, for "by an conventional" read -- by any conventional --; line 53, for "extending" read -- extend --; column 4, line 65, after "96" insert -- by --.

Signed and sealed this 25th day of February 1964.

(SEAL)
Attest:

ERNEST W. SWIDER

Attesting Officer

EDWIN L. REYNOLDS

Acting Commissioner of Patents