Dec. 30, 1969 R. P. VINCENT 3,486,555

SMALL DIAMETER RISER PIPE SYSTEM

Filed June 25, 1968 2 Sheets-Sheet 1

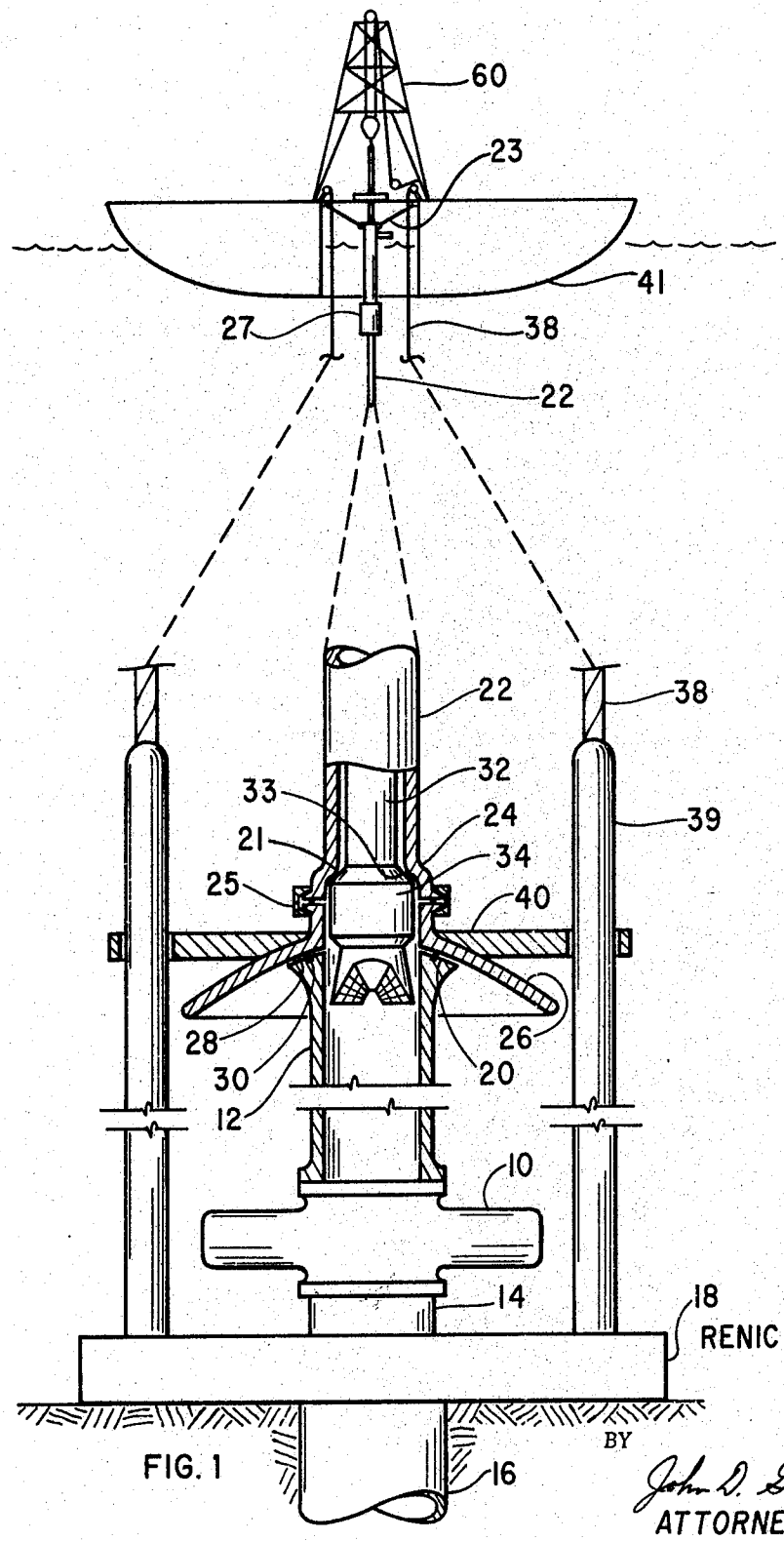


FIG. 1

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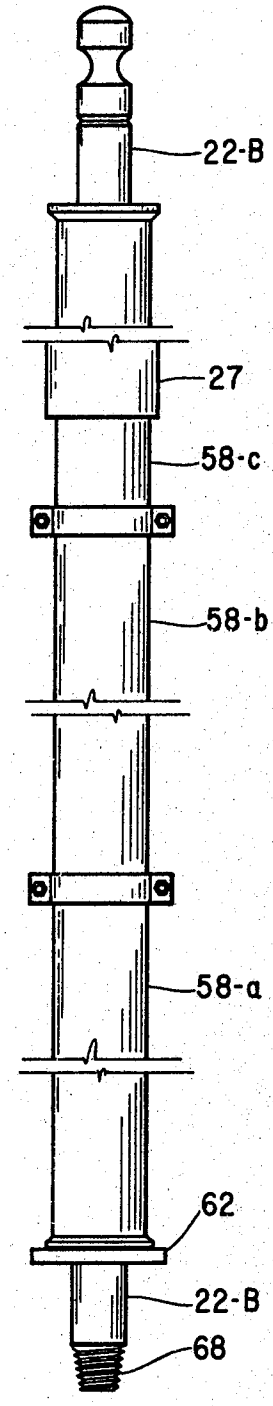


FIG. 3

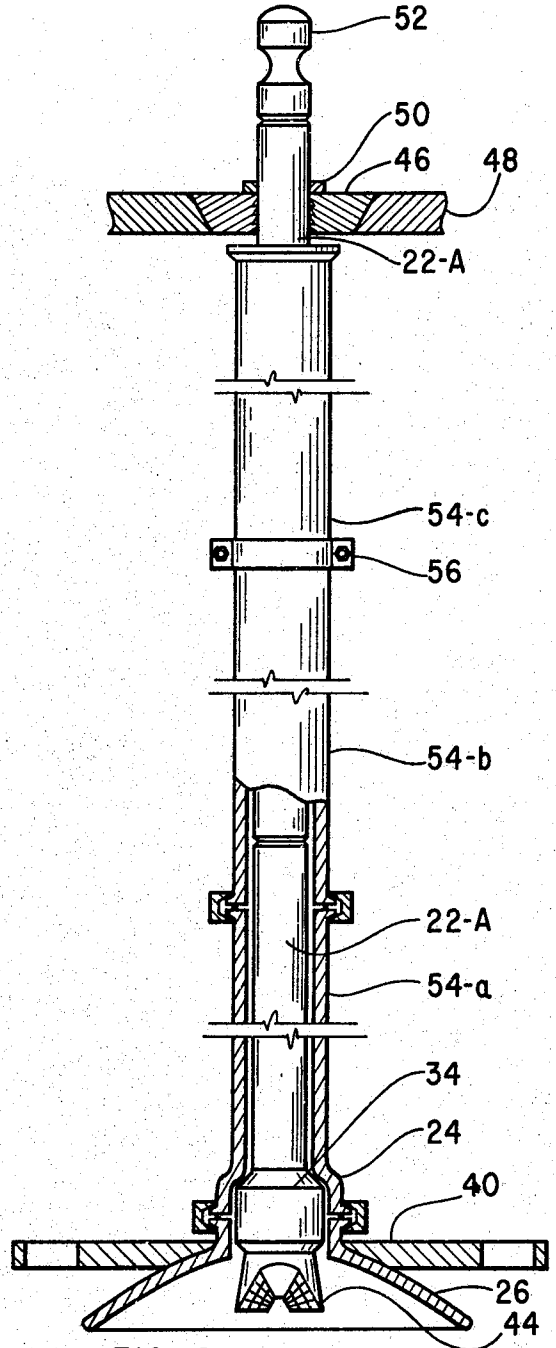


FIG. 2

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3,486,555

SMALL DIAMETER RISER PIPE SYSTEM

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U.S. Cl. 166—.5 8 Claims

ABSTRACT OF THE DISCLOSURE

This describes the use of a riser pipe which has an inside diameter only about one-half to one inch larger than the outside diameter of the drill collar and drill pipe which must pass therethrough. The riser pipe, when being raised or lowered, is supported by a special sub or enlarged section of drill pipe which is connected to the lower end of the drill string just above the bit. Buckling of the riser pipe is resisted by the stiffness of the drill pipe in tension. Means are provided to guide the lower end of the riser pipe into sealing engagement with the wellhead. Thus, no tensioning device is required on the vessel. By using this system, the weight of the riser system is reduced by a factor of between 10 and 20.

This invention relates to drilling in earth formations located beneath a body of water, such as in the Gulf of Mexico, in which the drilling operations are conducted from a floating vessel. More specifically, this invention relates to a method and apparatus involving a riser pipe which extends from the ocean floor to the floating vessel located at the surface of the body of water. It relates to a riser pipe which is only slightly larger than the drill pipe it passes through such that the weight of the riser pipe system is reduced, for example, by a factor of 10 to 20 over that of the conventional riser pipe.

Background

In recent years it has become desirable to use a floating vessel from which to drill wells in marine locations. In such operations the floating vessel is sometimes connected to a submarine well bore by a long tubular member through which drill pipe, drilling fluids, etc., pass between the vessel and the well bore. This long tubular member is commonly referred to as a riser pipe.

A submerged well head usually includes a blowout preventer and other control equipment. The control equipment is usually operated by hydraulic lines which extend from the equipment to the vessel. However, sonic instruments can be used for operating the control equipment. In one embodiment of the commonly used systems, the upper part of the well head assembly includes a ball connector which provides a flexible connection between the well head assembly and the riser pipe. The lower end of the riser pipe is connected to the ball joint and is free to pivot thereabout. This is commonly called a flex joint. The purpose of this is to permit relative pivotal movement between the riser pipe which is subject to forces such as the ocean current and the well head assembly which is secured to the earth. Other types of flex joints are commercially available; however, the ball and socket joint is enjoying increasing popularity. Although a vessel is anchored, it normally has some vertical movement and it can rise and fall from a few feet up to 20–30 feet or more. To compensate for this vertical movement, a slip or telescopic joint is provided in the riser pipe.

In conventional riser pipes which are supported solely at the lower end, its own effective weight, that is, weight in water, causes it to be in a state of axial compression increasing from zero at the top to a maximum at the bottom support. When drilling in deep water, the compressive stress in the wall of the riser pipe from this source alone is sometimes sufficient to buckle the riser pipe, that is, to cause it to bend. To counteract this buckling effect it has become a practice to apply a tensile force to the top of the riser pipe. Special tensioning devices are mounted on the ship and have their cables attached to the upper end of the riser pipe but below the slip joint. These tensioning devices are commonly referred to as constant tensioning devices so that they can maintain a constant tension on the riser pipe although the ship may rise and fall with respect to the riser pipe. These constant tensioning devices are helpful but are also costly and must be maintained. A failure of the tensioning device can be catastrophic.

In ordinary drilling using conventional riser pipe systems, the riser pipe may commonly be about 20 inches in diameter and the drill string which passes therethrough is commonly about 4½ inches in diameter. The relatively larger diameter of the riser pipe is provided so that the drill bit, etc., at the lower end of the drill string can pass readily through the riser pipe. In ordinary operations the drilling fluid circulates down through the drill pipe, out the bit at the lower end where the hole is being made, up the annulus, first between the drill string and the earth, and then between the drill string and the riser pipe. The bigger the riser pipe, the greater the stresses due to buckling, thus the greater the tensioning force which must be applied to keep it from buckling.

Brief description of the invention

Briefly, this invention concerns an improved riser pipe in which the riser pipe is only slightly larger than the diameter of the drill string. The lower end of the riser pipe sealingly fits and mates into an upwardly facing conical surface on the subsea well head. A drill string extends through the riser pipe and has an operational sub of a diameter larger than the drill string attached thereto. The sub has an outer diameter larger than the inner diameter of the riser pipe and supports the riser pipe when the riser pipe is being run into or removed from its operating position. Buckling of the riser pipe is prevented by having either heavy drill collars extending therethrough or when the drill pipe is in operation, the tension is the drill pipe imputes stiffness to the riser pipe. In this system, therefore, no tensioning device is required for the riser pipe.

Various objects and a better understanding of the invention can be had from the following description taken in conjunction with the drawings in which:

FIGURE 1 illustrates a preferred embodiment showing the riser pipe seated in the well head and extending to a drilling vessel at the surface;

FIGURE 2 illustrates several stands of drill collars attached to a special sub and bit and positioned inside small diameter riser pipe section;

FIGURE 3 illustrates the next stand, after that of FIGURE 2, of collars and riser assembled as used when running into the position of FIGURE 1.

Attention is first directed to FIGURE 1 of the drawing which illustrates a conventional subsea well head including a blowout preventer stack **10** having a vertical passage therethrough. The blowout preventer stack is supported by a casing **14** which is set in larger surface casing **16**. A guide base plate **18** is supported by casing **16**. A long spool **12** is attached to the upper end of the blowout preventer stack. Long spool **12** is somewhat greater in length than the maximum vertical displacement of the vessel due to wave and tides. The purpose of this will be explained hereinafter. The upper end of long spool **12** is provided with an upwardly facing conical surface **20**.

Show in the drawing is a riser pipe **22** which has a lower enlarged portion **24**. Attached to the lower end of the riser by clamp **25** is guide arm **40** and an inverted guide funnel **26** which has a lower sealing surface **28**. The guide arms **40** are loosely mounted on guide posts **39** to which guide lines **38** are connected and extend to the floating vessel **41**. The purpose of the funnel **26** is to aid in centering the surface **28** on the conical surface **20** of the long spool **12**. A seal **30** is carried by sealing surface **28** of the riser pipe **22**. It will be noted that the mating surface **28** of the riser pipe and the upwardly facing surface **20** of the spool **12** are spherical in shape so that they can pivot with respect to each other without losing their seal. Thus, they make up what can be called a flex joint. This permits the upper end of the riser pipe to move laterally with the tide without breaking contact with the spool.

Mounted within riser pipe **22** is a drill string **32**. The clearance between drill string **32** and riser pipe **22** is very small, being not over about one inch, for example. This clearance is kept small so that the stiffness of drill pipe **32** will be imputed into riser pipe **22** and prevent it from buckling. The upper end of riser pipe **22** is supported at the upper end from ship **41** by lines **23** and a conventional slip joint **27** of suitable size. No special tensioning means need be connected to lines **23**. It has been determined that the stiffness of the drill pipe **32** held in tension by the weight of pipe and drill collars suspended below the riser is sufficient to prevent buckling of the riser. The inherent stiffness of the drill collars is sufficient to prevent buckling of the riser as it is lowered in the well.

I will now consider the manner of supporting the riser by the drill string **32** when the riser pipe is either being run or removed. This is accomplished by having a special sub **34** attached to the lower end of drill pipe **32** just above bit **36**. Sub **34** is of a larger outside diameter than the inside diameter of riser **22**. Sub **34** has an upwardly facing shoulder **33** which mates with or engages the downwardly facing shoulder **21** at the lower end of riser **22**.

The length of spool **12** should be somewhat greater than maximum vertical displacement of the vessel due to wave and tide. It will be noted that the weight of the riser pipe **22** forces the surface **28** of funnel **26** downwardly against upwardly facing surface **20** to form a good seal. This seal is broken when sub **34** forces the riser pipe upwardly. Thus, by making the length of the spool greater than the maximum vertical displacement of the vessel, the blowout preventer **10** can be closed before the riser connection is broken. This is when pulling pipe. It also functions to permit the blowout preventers to remain closed until the seal is made between the riser and the spool.

FIGURE 2 is a view of the riser pipe assembly including drill collars. Shown thereon are a plurality of drill collars **22A** having enlarged sub **34** just above bit **44**. The drill collars **22A** are held in place by slips **46** in rotary table **48**. A safety clamp **50** has been positioned about the drill collars just above the slip. A pickup sub **52** is connected to the top of the top of the drill collars **22A**. Mounted about the drill collars are a plurality of stands of riser pipes **54***a*, **54***b* and **54***c*. These stands of riser pipes are connected by suitable riser connectors **56**. The lower stand **54***a* of the riser pipe is enlarged at the bottom similarly as shown in FIGURE 1 to provide an enlarged portion **24** having guide arm **40** and guide funnel **26** connected thereto.

FIGURE 3 illustrates a string of drill pipe or drill collars **22B** closely surrounded by three stands of riser pipes **58***a*, **58***b* and **58***c* connected by suitable riser connectors. A safety clamp **60** is placed about drill collar string **22B** just below the stand of riser pipe **52***a*.

When it is desired to run the riser pipe into the hole, the first step is to place several stands of riser pipe such as **52***a* having enlargement **24** at the lower end about the string of pipe just above sub **34**. The various stands of riser pipe are connected as by clamps **56**. The riser pipe is stripped down over the drill string while the pipe is still in the derrick supported above the working deck. The whole device is then picked up by the hoisting means on rig **60** and lowered down through slips **46** which are in their open position. As soon as the lower end of riser pipe section **54***a* is clear below the rotary table, guide arms **40** and guide funnel **26** are connected thereto by clamp **25**. The whole assembly is lowered to the position shown in FIGURE 2. The slips are then set as illustrated.

At this time another set of drill collars **22B** such as shown in FIGURE 3 mounted in riser section **58***a*, **58***b* and **58***c* is supported in the derrick **60**. Safety clamp **62** mounted on drill collar **22B** some distance sufficient to allow tongs to be used on the drill collar below the clamps prevents the riser pipe **58***a* from falling down over the lower end of drill collar **26B** of FIGURE 3. The drill collar is picked up by pickup sub **52** which is now on the top of drill collar section **22B**. The drill collar and riser of FIGURE 3 are then lowered and the threads **68** of drill collar **22B** are connected into the threads of the upper section of the drill collars of FIGURE 2. At this point the riser section **58***a*, etc., is picked up by a catline or other auxiliary means, not specifically shown, and supported from derrick **60**. Safety clamp **62** is removed and the riser section is lowered so that riser section **58***a* can be clamped or connected to the upper end of previously installed riser pipe section **54***c*. Additional stands of riser pipe and drill collars are added until the riser pipe has reached the desired length so that it can rest and seat on seat **20**.

A brief discussion of the procedure of removing the riser pipe assembly will now be made. The drill pipe is removed by the use of derrick **60** in a conventional manner until the sub **34** is raised to the position illustrated in FIGURE 2. Pickup sub **52** is placed on the upper end of the drill collars, the slips **46** released and the entire assembly of FIGURE 2 below the table **48** is raised by the raising of the drill collars. When the drill collars have been raised their maximum distance, such as 2 or 3 joints, the upper two or three stands of riser pipes are disconnected from the lower stands of riser pipe. An auxiliary hoist lifts the riser stand up sufficiently so that a safety clamp can be placed about the drill collars just below the lower end of the disconnected riser pipe section, such as safety clamp **62** of FIGURE 3. Then the auxiliary means for lifting the riser pipe is removed and the upper section of drill collars such as **22B** is disconnected from the upper portion **22A** after portion **22A** is firmly supported by the slips. The safety clamp **62** is used to support the riser pipe assembly on the stand of drill collars. The remaining drill collars are now lowered so that the remaining riser pipe joints are below table **48**. The slips **46** are now set on the drill collars so that the drill collar joint immediately above the table can be broken out. Then we have a section broken out as shown in FIGURE 3. This can be stored on the deck. Ideally, the sub **52** is of sufficient length to give greater length to the string of drill collars for manipulating the riser pipe sections thereabout. This process is repeated until all the riser pipe assembly as desired is pulled from the hole.

While the above embodiments of the invention have been described with considerable detail, it is to be understood that various modifications of the device can be made without departing from the scope or spirit of the invention.

I claim:

1. A riser pipe system for use with a well in the floor of a body of water which comprises:

a well head having an upwardly facing surface and a vertical passage therethrough;

a drill string having a hollow sub member connected

into the lower end portion thereof, said sub being insertable in the vertical passage of said well head, said sub member having a larger diameter than the other part of said drill string;

a riser pipe surrounding said drill string, the internal diameter of said riser pipe being less than the diameter of said sub member, the lower end of said riser pipe having a downwardly facing surface for mating and sealing with the upwardly facing surface of said well head.

2. An apparatus as defined in claim **1**, including guide means to guide said riser pipe and drill string downwardly to engagement with said well head.

3. An apparatus as defined in claim **1** in which the outside diameter of said drill string is not over about one inch less than the inside diameter of said inside diameter of said riser pipe.

4. An apparatus as defined in claim **2**, including a downwardly opening funnel secured to the lower end of said riser pipe for guiding the riser pipe into engagement with the upwardly facing surface of said well head.

5. A riser pipe system as defined in claim **1** for use in a floating vessel having a vertical movement due to waves and tide which comprises:

said well head including a hollow spool of a vertical length greater than the vertical movement of the floating vessel, said well head further including a blowout preventer connected to the lower end of said spool.

6. A riser pipe assembly as defined in claim **1** in which the downwardly facing surface of the riser pipe and the upwardly facing surface of the well head are spherical.

7. A method of removing a riser from engagement with a well head in which the riser is made up of at least two joints clamped together, a drill string inside said riser and having a sub of larger diameter than the inner diameter of said riser pipe, which comprises:

pulling up on said drill string until said sub engages the lower end of said riser pipe, continue pulling on said drill string until at least one joint of said riser pipe has cleared the work deck on said ship;

disconnecting the said first joint from said second joint;

securing the disconnected joint of the riser pipe;

lower the drill pipe and the lower section of riser pipe so that the top of the lower section of riser pipe is below the work deck;

then secure the drill collar to the work deck;

disconnect the joint of drill pipe above where it is secured;

store the disconnected joint of drill pipe and riser pipe.

8. A method of running riser pipe from engagement with the well head in which the riser is made up of at least two joints clamped together, drill string inside said riser and having a hollow sub at the lower end thereof of larger diameter than the inner diameter of said riser pipe which comprises:

stripping at least one joint of riser pipe down over a section of drill string until the lower end of the riser pipe presses on said sub;

lowering the drill pipe and riser down through the rotary table;

placing another section of riser pipe over another section of drill string;

placing a safety clamp about the lower end of said second section of drill pipe to support the riser pipe section;

connecting the second section of drill pipe to the first section supported in said rotary table;

lifting up on said second section of drill pipe;

independently lift up on said second section of riser pipe until the weight is removed from said clamp on said second section of drill pipe;

removing said safety clamp;

independently lowering said second section of riser pipe;

clamping said second section of riser pipe to said first section;

thereafter lowering said connected sections of drill pipe and said connected sections of said riser pipe;

repeating the above steps until said riser pipe engages said well head.

References Cited

UNITED STATES PATENTS

3,145,775	9/1964	McCarty	166—.5
3,247,914	4/1966	Slack	166—.5 X
3,319,726	5/1967	Brown	166—.5 X
3,338,303	8/1967	Hoch et al.	166—.5
3,340,928	9/1967	Brown	166—.5
3,369,599	2/1968	Evans	166—.5
3,422,889	1/1969	Yost	166—.5

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U.S. Cl. X.R.

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