July 8, 1969 W. A. HUNSUCKER 3,454,116

RISER PIPE ASSEMBLY FOR OFFSHORE DRILLING OPERATIONS

Filed Oct. 26, 1966 Sheet 1 of 2

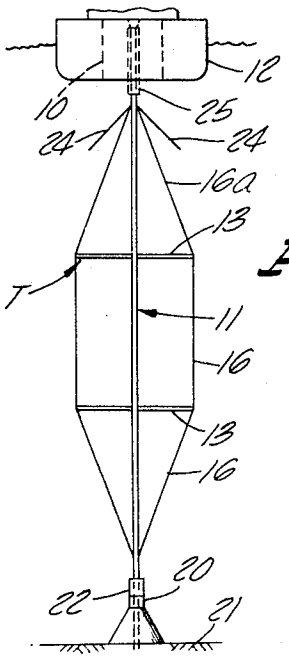


FIG. 1.

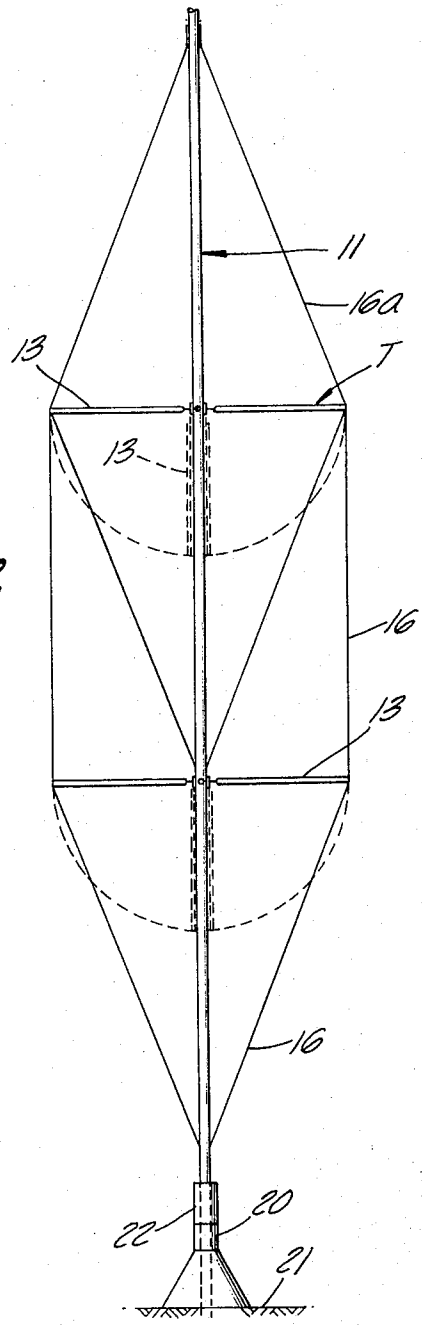


FIG. 2.

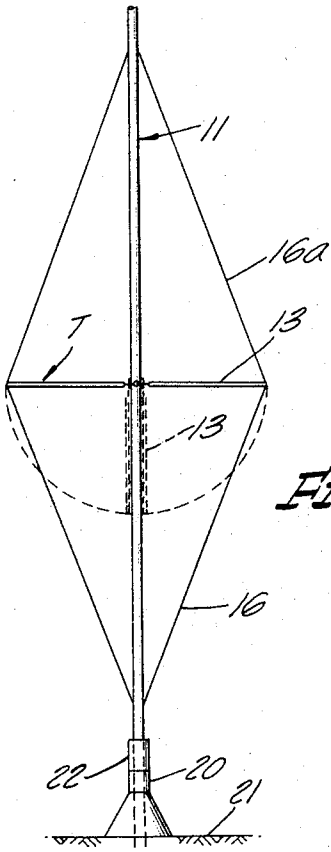


FIG. 3.

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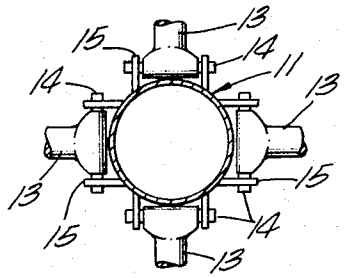


FIG. 4.

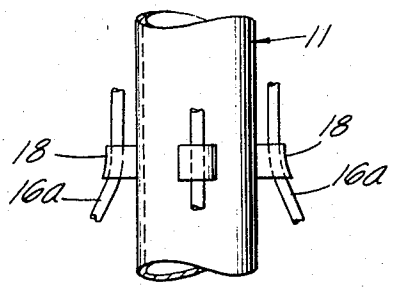


FIG. 5.

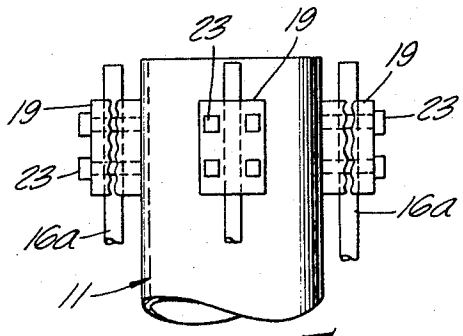


FIG. 6.

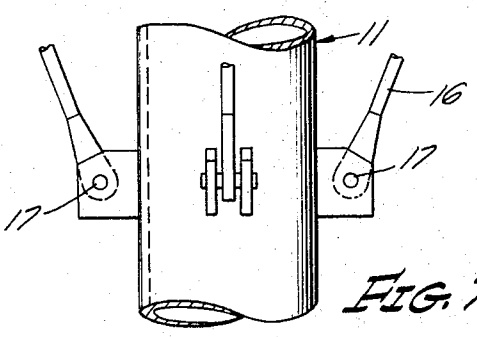
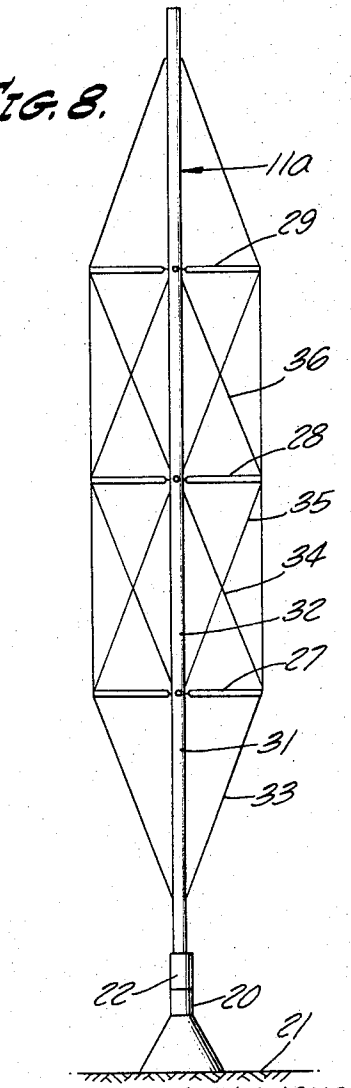


FIG. 7.

FIG. 8.



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RISER PIPE ASSEMBLY FOR OFFSHORE DRILLING OPERATIONS

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U.S. Cl. 175—7 8 Claims

ABSTRACT OF THE DISCLOSURE

A riser pipe assembly for guiding drilling tools from a floating vessel or drilling platform into a well head on the floor of a body of water includes a riser pipe having a plurality of external stiffener trusses mounted thereon, each truss comprising parts movable from a collapsed position small enough to pass through the drilling opening on the vessel or platform to an expanded position substantially larger than the drilling opening to stiffen the riser pipe against bending.

This invention relates to apparatus for stiffening the riser pipe, or conductor pipe, through which well drilling operations are conducted in submerged offshore areas.

The riser pipe, or conductor pipe, extends from the sea bed or ocean floor to near the surface of the water from which drilling operations are conducted. The riser pipe provides a conduit to return to the vessel or platform the flow of drilling mud delivered to the bit in the drilling operation. It also serves as a guide for the hollow drill pipe which rotates the bit. The present practice is to use a pipe extending from the sea bed to a floating vessel or stationary platform from which drilling operations are conducted. For moderate depths of water the length of the pipe is so great that it becomes very flexible and bends or deflects because of loads induced by action of waves or currents, or because of its own weight. This condition is aggravated because the pipe usually is required to contain a drilling mud of high density which weighs more than an equal volume of the surrounding sea water. Such bending, or deflections, of the pipe interferes with drilling operations and in some cases has resulted in breaking of the riser pipe and a consequent expensive interruption of the drilling operations.

Heretofore, efforts have been made to reduce the bending, or deflection, of the riser pipe by the use of counterweights to which steel cables are attached. The steel cables extend over sheaves, which are supported by the vessel, and are attached to the top of the riser pipe. Thus, a tension force is exerted on the pipe in an effort to maintain it in a straight position. Very massive counterweights have been used without being completely successful. This method is very cumbersome and expensive. Other devices have been used in an attempt to maintain the pipe in a straight position. None of these methods has proven completely satisfactory.

The present invention provides means whereby the riser pipe is stiffened by means of an expansible truss composed largely of tension members or cables. Furthermore, the stiffening means is not in the vicinity of the vessel or platform and hence does not interfere with drilling operations.

A primary object of my invention is to provide novel means to stiffen the riser pipe, or conductor pipe.

Another object is to minimize interference with drilling operations.

Another object is to provide a suitable and safe means to conduct the heavy fluids required in drilling operations at a minimum cost.

Another object is to provide a stiffened riser pipe assembly for use with a floating vessel for well drilling operations, which riser pipe is free-standing from the sea bed, and may remain in place in the absence of the vessel.

Briefly stated, these and other objects of the invention are achieved by incorporating the riser pipe as part of an expansible truss composed in part of tension members or cables; the truss being expanded into its operating position by exerting a tension force on the tension members or cables from the vessel or platform. Guy wires extending from the upper portion of the riser pipe to the ocean floor support the truss-stiffened riser pipe in free-standing position.

Reference is now directed to the drawings, in which:

FIGURE 1 is a side view in diagrammatic form illustrating a preferred embodiment of the invention.

FIGURE 2 is a similar view showing an expansible truss integral with the riser pipe.

FIGURE 3 is a similar view showing an alternate construction for an expansible truss.

FIGURE 4 is an enlarged plan view showing attachment of the strut members to the riser pipe.

FIGURE 5 is an enlarged side elevation showing the means for controlling the position of tension members in relation to the riser pipe.

FIGURE 6 is a fragmentary side elevation showing attachment of the tension members to the riser pipe near the top of the riser pipe.

FIGURE 7 is a similar view showing attachment of the tension members to the riser pipe near the bottom of the riser pipe.

FIGURE 8 is a view similar to FIGURE 2, showing a modification.

Referring to the drawings, external trusses T are provided to stiffen the riser pipe **11**. One truss would be sufficient to stiffen the riser pipe **11** with predominantly tension members if it were properly located in the plane in which the loads were being applied on the riser pipe. Since the direction in which the loads will be applied on the riser pipe **11** cannot be known in advance, trusses must be present in such position that loads from any direction will be resisted by a truss or a combination of trusses. In the drawings, four trusses T are shown positioned at 90° to each other. Thus, one or more trusses would always be in position to resist loads from any direction. Furthermore, the four sets of trusses provide lateral support for the riser pipe at the points where the struts are attached to the riser pipe. Thus, the riser pipe **11** is enabled to sustain its own weight without buckling. Fewer or more than four trusses could be used for the above purposes. The primary requirement is that sufficient trusses be used and positioned so as to be able to resist load from any direction and to provide lateral support for the riser pipe at the locations where the struts are attached thereto.

It should be noted that the drilling opening **10** in the floating vessel **12**, or platform (not shown), through which drilling operations proceed, is not large enough to permit the passage of a truss of sufficient size to be effective in resisting loads induced on the riser pipe **11**. In accordance with the present invention, the truss can be expanded into working position after the riser pipe **11** and collapsed truss assembly have been lowered through the drilling opening, or otherwise have reached a position below the drilling floor.

The hinge arrangement shown in FIGURE 4 is used to permit expansion of the truss members from collapsed to extended position. The strut members **13** are welded to heavy pins **14** which turn within supporting brackets **15** fixed on the riser pipe **11**. Thus, the struts **13** can be folded in a dotted-line position approximately parallel to the riser pipe **11** with the tension members **16** at-

tached in place to the struts **13** and the riser pipe **11**. See FIGURES 2 and 3. Thus, the entire assembly of riser pipe **11**, struts **13**, and tension members can readily pass through a drilling opening **10** of minimum size and later be expanded into trusses of much larger dimensions. The position of the pins **14** and the supporting brackets **15** permits movement or rotation of the struts **13** to occur only in planes which include the riser pipe **11**. Thus, the expanded position of the members of each truss T can be predetermined.

The lower end of each tension member **16** is attached to the riser pipe **11** near the sea bed by suitable means such as a bolt or a pin **17**. The upper tension member **16*a*** passes through the guide member **18**, as shown in FIGURE 5, and is continued to a point near the top of the riser pipe **11**. After the struts and tension members are expanded so as to form trusses, the upper tension members can be firmly attached to the riser pipe **11** by suitable means such as cable clamps **19**.

In order to better understand the means for stiffening the riser pipe, the steps of installing the riser pipe **11** and the expansible trusses will now be described.

After the vessel **12** has been placed in position and anchored at a selected site, or the platform erected at the site, the well head **20** is placed and firmly anchored in the sea bed in the manner well known to those skilled in this art. At this point, the lower section of the riser pipe **11** is assembled on the vessel along with the lower tension members **16**, the lower struts **13** and the upper tension members **16*a***. This assembly is in a folded or collapsed position with the struts **13** in approximately a parallel position to the section of riser pipe **11**, and the tension members **16** and **16*a*** hanging loosely from the end of the struts **13** and the riser pipe **11**. This folded assembly is then lowered through the opening **10** in the vessel **12**, and a second similar folded assembly, if necessary, is attached to the top of the first assembly. Proceeding in this manner, sections of the riser pipe **11** and the related struts and tension members are passed through the opening **10** in the vessel **12** and are guided into the well head **20** in the procedure commonly followed in attaching the riser pipe **11** to the well head **20**, with its blowout preventer **22**. After the lower end of the riser pipe is firmly attached to the well head, a tension force is exerted on the upper tension members **16*a***. Thus, turning motion is enforced on the struts **13** about the pins **14** to the limit permitted by the lower tension members **16**. At this time the struts and tension members are in an expanded position. Then bolts **23** are attached in cable clamps **19**, near the upper end of the riser pipe **11**, and the upper tension members are firmly secured to the upper portion of the riser pipe **11**. The combination of tension members, struts and riser pipe then constitutes a group of trusses T suitable for resisting loads that may be applied on it. Since, in this case, four such trusses are formed, lateral loads from any direction can be resisted. Also, the trusses provide lateral support for the riser pipe where the struts are attached thereto, and it is thus enabled to sustain its own weight or additional loads in action as a column. It acts effectively as a guide for drilling tools in entering the well head.

From the foregoing it is evident that the riser pipe **11** can perform its usual functions of providing a means to return the flow of drilling mud to the supporting vessel **12** or platform, and guiding the drill pipe, and in addition is now a component of a system of expansible trusses capable of resisting lateral loads from any direction, and the riser pipe proper is stiffened by the members of the expansible trusses so that it can resist vertical loads applied along its longitudinal axis.

Guy wires **24** anchored to the sea bed **21** may be used to hold the upper end of the riser pipe **11** in free-standing position, so that the vessel **12** may move away, and return, if necessary. A movable telescoping joint **25** may extend from the upper end of the riser pipe into the drilling opening **10**. The upper end of the free-standing riser pipe makes it easier to re-enter the well with drilling tools, because it is closer to the water surface than the submerged well head **20**, and no guide lines are required.

In order to remove the expanded trusses and the riser pipe associated therewith, the procedures described above for installing the apparatus are reversed. The clamping means which attach the upper tension members near the top of the riser pipe are released, and the removal of tension in these tension members permits the strut members to swing into a collapsed position in close proximity with and approximately parallel to the riser pipe. Thus, the tension members, struts and the riser pipe, which in an expanded position occupied a substantial dimension in space surrounding the riser pipe, now are relatively compact and can readily be removed through opening **10** in the vessel **12**.

Under certain conditions, particularly where the water depth is great, it may be desirable to use two diagonal tension members between strut members **27**, **28** and **29**, as shown in FIGURE 8. It may also be desirable to follow the modified procedure described below in expanding the trusses as the assembly of riser pipe and truss members is installed. The riser pipe **11*a*** is composed of sections of pipe of the required diameter connected together end to end, and of the number of sections necessary to extend from the sea bed to near the surface of the water. The lowermost sections **31** and **32** of the riser pipe **11*a*** may be connected together along with the lower struts **27** and tension members **33** and **34** with parts being in a folded position in close proximity to parts **31** and **32**. Thus, these members can readily pass through the opening **10** in the vessel or platform. Before the upper end of member **32** reaches a point below the surface of the water, the subassembly consisting of the struts **27** and the connecting tension members **33** and **34** are expanded into their operating positions by exerting tension on the upper ends of members **34**, which can then be clamped into position by suitable means such as the clamps shown in FIGURE 6. Continuing in a similar manner, another subassembly including struts **28** is then expanded into operating position by exerting tension on members **35** and **36**, and clamping them into position. In a similar manner, as many subassemblies as are necessary for the depth of water can be added, lowered, expanded, and clamped in position. A system of trusses is thus provided extending outwardly in four directions, in this case, from the riser pipe **11*a***, and the stiffened riser pipe is then in position and ready to resist lateral as well as vertical loads, and to serve as a means to conduct the flow of drilling fluid and to serve as a guide for the drill pipe.

Having fully described my invention, it is to be understood that I am not to be limited to the details herein set forth but that my invention is of the full scope of the appended claims.

I claim:

1. In combination with a floating vessel or drilling platform from which drilling tools can be lowered, a well head on the floor of a body of water, a riser pipe assembly insertable down through the body of water from the vessel or platform for connection to the well head, said assembly including a riser pipe shaped to receive and guide the drilling tools, and a plurality of external stiffener trusses mounted on the riser pipe, each truss comprising parts movable from a collapsed position to an expanded position to provide external stiffening for the riser pipe.

2. The combination set forth in claim **1** in which each truss is formed by at least one radial strut movably mounted on said pipe, and a cable connected to the outer end of the strut.

3. The combination set forth in claim **1** in which each truss is formed by a plurality of radial struts in the same plane and hinged to the pipe, and cables connected to the outer ends of the struts.

4. For use with a floating vessel or drilling platform

having a drilling opening through which drilling tools can be passed for entry into a well head on the floor of a body of water, the improvement comprising, in combination: a riser pipe assembly insertable through the drilling opening and down through the body of water for connection to the well head, said assembly including a riser pipe shaped to receive and guide the drilling tools, a plurality of external stiffener trusses mounted on the riser pipe, each truss comprising parts movable from a collapsed position small enough to pass through the drilling opening to an expanded position substantially larger than the drilling opening, whereby the riser pipe assembly may be lowered through the drilling opening with the trusses in collapsed position, and the trusses subsequently expanded to provide external stiffening for the riser pipe.

5. The combination set forth in claim 4 in which each truss is formed by at least one radial strut movably mounted on said pipe, and a cable connected to the outer end of the strut.

6. The combination set forth in claim 4 in which each truss is formed by a plurality of radial struts in the same plane and hinged to the pipe, and cables connected to the outer ends of the struts.

7. For use with a floating vessel from which drilling tools can be passed for entry into a well head on the floor of a body of water, the improvement comprising, in combination: a riser pipe assembly insertable down through the body of water for connection to the well head, said assembly including a riser pipe shaped to recline and guide the drilling tools, a plurality of external stiffener trusses mounted on the riser pipe, each truss comprising parts movable from a collapsed position to an expanded position, and guy wires extending from the upper portion of the riser pipe assembly to the ocean floor to maintain the riser pipe assembly in free-standing position on the well head, in the absence of the floating vessel.

8. For use with a floating vessel having a drilling opening through which drilling tools can be passed for entry into a well head on the floor of a body of water, the improvement comprising, in combination: a riser pipe assembly insertable through the drilling opening and down through the body of water for connection to the well head, said assembly including a riser pipe shaped to receive and guide the drilling tools, a plurality of external stiffener trusses mounted thereon, each truss comprising parts movable from a collapsed position small enough to pass through the drilling opening to an expanded position substantially larger than the drilling opening, and guy wires extending from the upper portion of the riser pipe assembly to the ocean floor to maintain the riser pipe assembly in free-standing position on the well head, in the absence of the floating vessel.

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ALFRED R. GUEST, *Primary Examiner.*

U.S. Cl. X.R.

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