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Schuh

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[54] **TENSION-LEG PLATFORM**

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[52] **U.S. Cl.** ..... **114/.5 D;** 9/8 P

[51] **Int. Cl.²** **B63B 35/44**

[58] **Field of Search** ..... 114/.5 D, .5 R, 206 R, 114/230; 9/8 P; 61/46.5; 254/172

[56] **References Cited**

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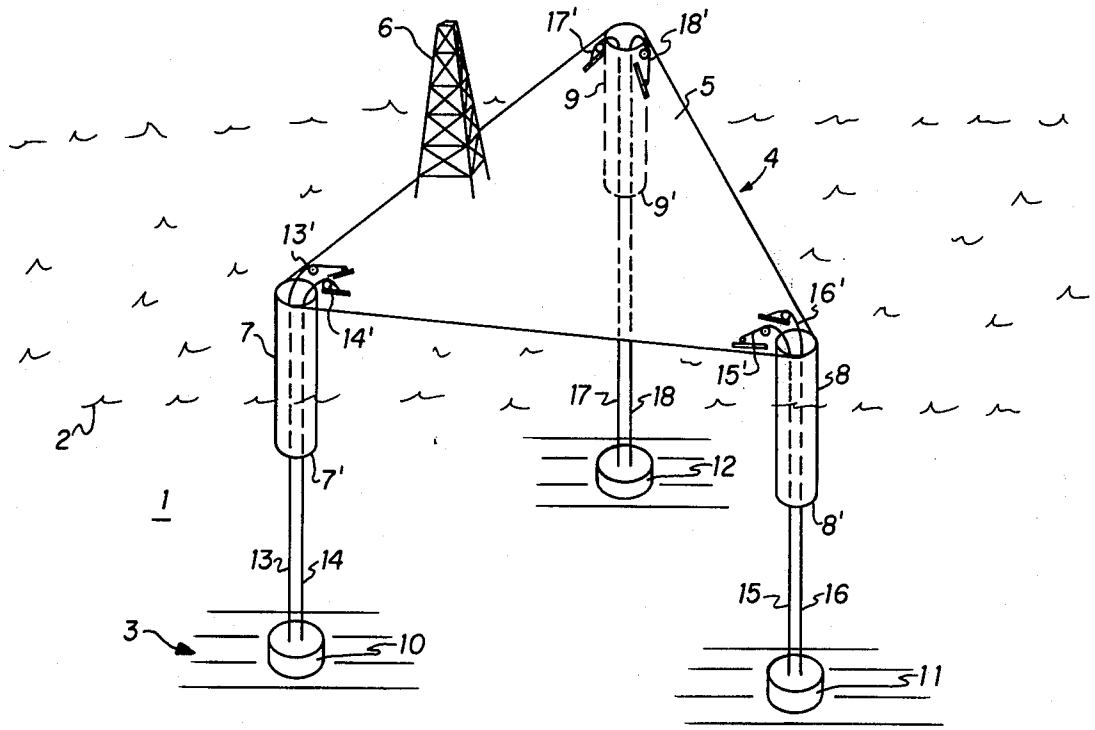
[57] **ABSTRACT**

A tension-leg drilling/production platform which has a plurality of legs, each leg having a plurality of flexible lines which connect to an anchor. A power device, e.g., a chain windlass, is associated with each line for retracting and paying out that line and each power device is supported on the platform by an individual device such as a hydraulic piston and cylinder so that each power device is essentially vertically independently movable relative to the platform and this vertical movement can be at least partially controlled by the individual device to help control the tension in its associated line. This invention allows varying the tension in the lines for a given leg so that each line in that leg is under substantially the same tension load. The individual device can be individually adjusted to equalize the tension load of the lines in a given leg. Also, the individual device of a given leg can be interconnected with one another so that movement of one power device in that leg is automatically balanced with the other power device in that same leg thereby automatically maintaining all lines on that leg under substantially the same tension load.

7 Claims, 2 Drawing Figures



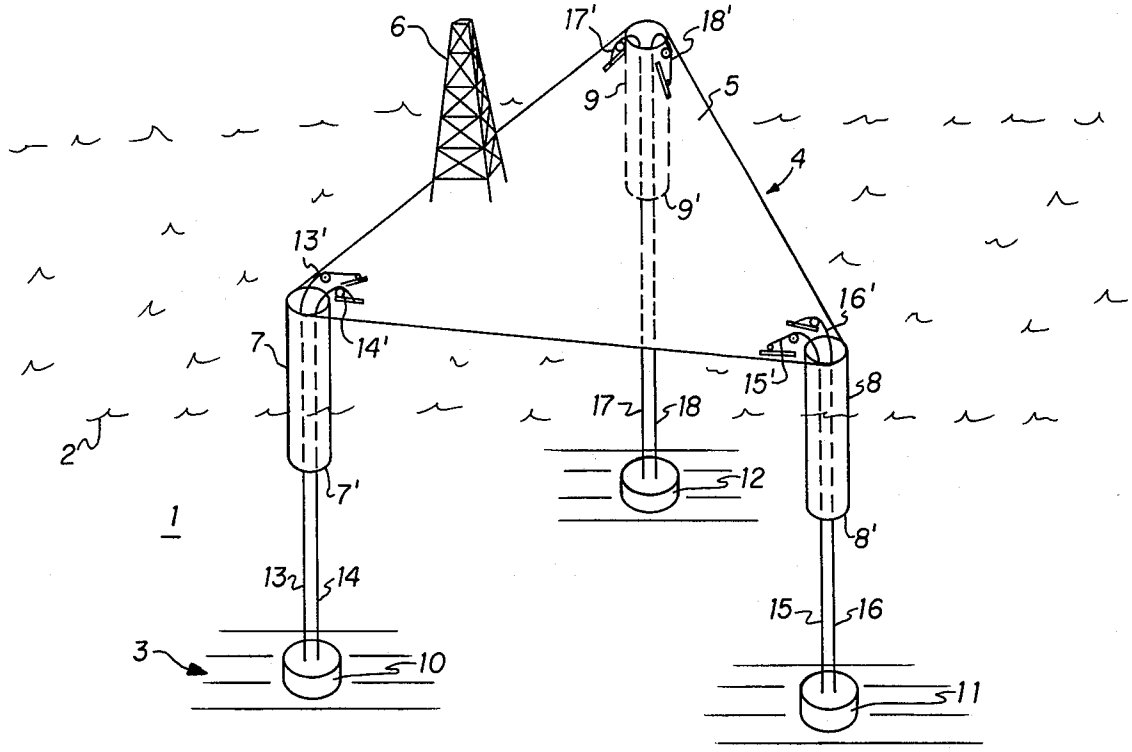
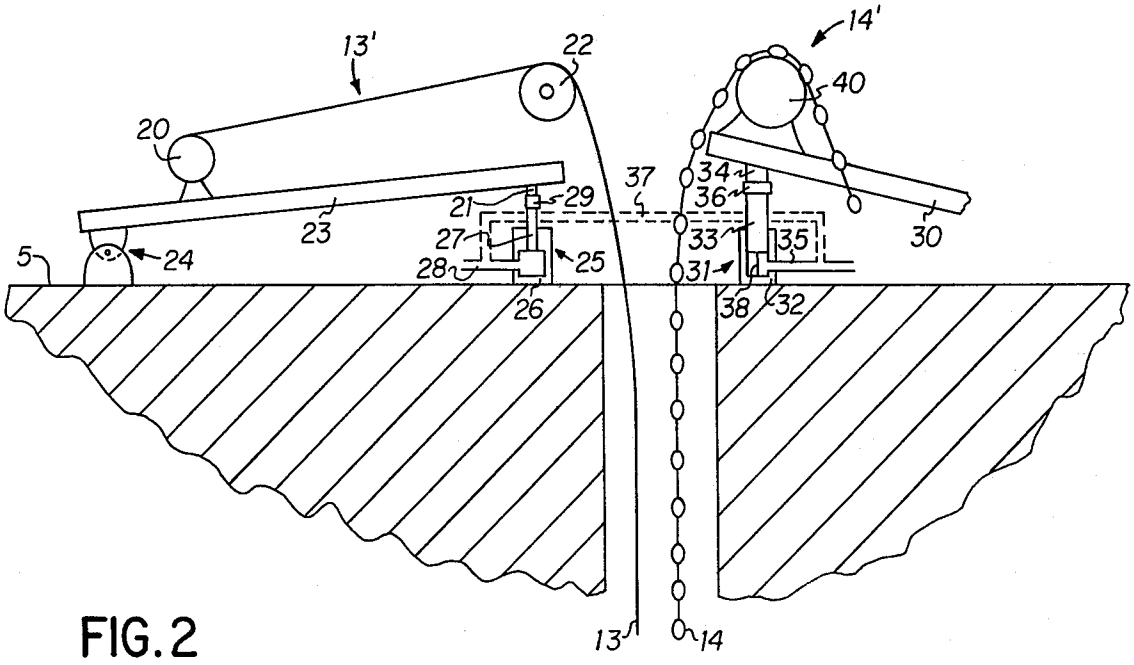

6
17'
18'
9
5
4
9'
13'
16'
14'
7
15'
8
17
18
2
12
7'
1
8'
13
14
15
16
3
10
11

FIG. 1


13'
22
14'
40
20
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34
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23
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28
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13
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FIG. 2

TENSION-LEG PLATFORM

BACKGROUND OF THE INVENTION

Heretofore, tension-leg platforms have been proposed for use in deep water well drilling. Such platforms are fully and completely disclosed in the OIL AND GAS JOURNAL, Oct. 8, 1973, Vol. 71, No. 41, page 88 et seq., the disclosure of which is incorporated herein by reference.

Generally, such platforms are triangular in shape and have three upstanding leg portions each composed of a hollow cylinder. Through each leg portion passes a plurality of lines, e.g., steel cable, chain, and the like, which extend downwardly from the platform through the water below the lower end of the leg portion to the ocean floor whereat the lines are connected to an anchor. Normally, each leg has its own individual anchor to which its lines are connected. These lines are under tension because they are holding the floating platform in place. Therefore, when the anchors are in place on the ocean floor, the lines serve as flexible legs for holding the platform in place. However, when it is desired to move the platform, the lines can be retracted thereby pulling the anchors off the ocean floor upwardly as far as desired, even to the bottom of the leg portion of the platform. In such a case the platform can then be moved to another drilling or production location.

Safety and numerous other requirements dictate that several lines be used to anchor each leg of the platform. For example, the greater number of lines per leg, the lower will be the change in individual line tension should one line fail.

Generally, the elasticity of the required line is so low that it is very difficult to balance the tension between the several lines on a given leg. Further, due to movement of the water itself, the line position is most desirably changed with each shift of the platform in order to maintain substantially equal tension among the lines of a given leg, but the power requirements to automatically adjust the tension or position of the individual line can be quite expensive and even more difficult to maintain.

Thus, a simple yet effective means for maintaining the tension of the lines in each leg substantially equal at all times while a tension-leg platform is floating in the water is highly desirable.

SUMMARY OF THE INVENTION

According to this invention, apparatus is provided which can maintain the lines in a given leg under substantially equal tension load in a simple and efficient manner. The apparatus can be interconnected on a given leg so that the tension in the lines is automatically adjusted to maintain all lines under substantially the same load. This is accomplished by employing a power means on each line for retracting and paying out that line, and supporting that power means in an essentially vertically movable manner on an individual means such as a hydraulic means so that movement of the hydraulic means causes movement of the power means (and vice versa) and also causes an adjustment in the tension of the line associated with that power means. The individual hydraulic means around a given leg can be interconnected with one another so that movement of one power means is automatically balanced with the other power means on that leg thereby automatically maintaining all lines on that leg under substantially the same tension load.

Accordingly, it is an object of this invention to provide a new and improved floating platform. It is another object to provide a new and improved well drilling and production platform for offshore use. It is another object to provide a new and improved apparatus for adjusting the tension in the lines in a tension-leg platform.

Other aspects, objects and advantages of this invention will be apparent to those skilled in the art from this disclosure and the appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** shows a tension-leg drilling/production platform floating in the water with its anchors sitting on the ocean floor.

FIG. **2** shows power means supported by individual hydraulic means in accordance with an embodiment within this invention, the power means being associated with one leg of the platform of FIG. **1.**

DETAILED DESCRIPTION OF THE INVENTION

There is shown in FIG. **1** a section of ocean **1** with the ocean surface **2** and ocean floor **3.** A tension-leg drilling/production platform **4** is floating in the ocean **1** and is composed of a working deck **5** which carries rig **6** and other working apparatus (not shown) and has three upstanding leg portions **7, 8** and **9** which are connected to deck **5** and extend downwardly through the surface of the water **2** into the water itself a certain distance. The bottoms **7', 8'** and **9'** of these leg portions terminate above the ocean floor so that there is a substantial distance between bottoms **7', 8'** and **9'** and anchors **10, 11** and **12** which are sitting on the ocean floor **3.**

For leg portion **7,** two lines **13** and **14,** which can be steel cable, chain, and the like so long as they are flexible in the same manner as cable, chain and the like, are connected to anchor **10** and extend through a hollow part of leg portion **7** to deck **5.** Lines **13** and **14** are connected to the platform by conventional means **13'** and **14'** such as the power means used to retract and play out lines **13** and **14.** In this invention there is such a power means for each of lines **13** and **14** so that elements **13'** and **14'** in FIG. **1** represent for this invention the individual power means just described for lines **13** and **14,** respectively. Each power means can have associated therewith means for locking the line in a specific position, all of this being well-known and obvious to one skilled in this art.

Similarly, lines **15** and **16** connect anchor **11** and deck **5** by way of power means **15'** and **16'** and these lines together with leg portion **8** compose this leg of the platform.

Also, lines **17** and **18** with their associated power means **17'** and **18'** interconnect deck **5** and anchor **12** and together with leg portion **9** compose the back leg of the platform.

According to this invention the power means for each leg is individually supported on its own hydraulic means as shown hereinafter in FIG. **2.** Thus, each power means shown on deck **5** is individually movable essentially in a vertical manner and is supported by its own hydraulic means so that each power means can be moved vertically thereby adjusting the tension in its associated line.

FIG. 2 shows two suitable devices for power means 13' and 14' of FIG. 1.

Power means 13' is shown to have a conventional winch and spool means 20. Line 13 is a steel cable that passes over a conventional pulley (fairlead) 22. Winch 20 is for retracting or paying out line 13. The cable is wound up on the spool. Power means 14' is shown to have a conventional chain windlass 40 since line 14 is shown to be a chain in FIG. 2. The chain falls by gravity into a chain locker (not shown) on or in deck 5. The particular type of power means employed varies with the type of lines used and is not important to this invention because such apparatus is well-known and obvious in the art.

In accordance with this invention, power means 13' is carried on a support member 23 which is physically connected to deck 5 by way of hinge means 24 so that power means 13' can move essentially vertically with respect to deck 5. To support the power means 13' in an essentially vertically movable manner there is employed in accordance with this invention a hydraulic means 25 composed of a hydraulic cylinder 26 and piston 27 with pipe 28 communicating with the interior of cylinder 26 to force piston 27 up or down as desired thereby raising or lowering power means 13 in an essentially vertical manner. Piston 27 is connected to shoulder 21 on support 23 by way of rotatable connection 29, e.g., a ball joint.

Similarly, power means 14' is carried by support 30 which also is hinged (not shown) to deck 5 in the same manner as shown for support 23, i.e., hinge means 24. Movable support 30 is supported by hydraulic means 31 which is composed of a cylinder 32, piston 33 and pipe 35 communicating with the interior of cylinder 32. Piston 33 is also connected to support 30 by way of shoulder 34 which is fixed to support 30 and to rotatable connecting means 36.

Power means 13' can be moved up or down to adjust the tension in line 13 by control of the fluid flowing into or out of cylinder 26 by way of pipe 28. Similar reasoning applies to power means 14' and line 14.

If desired, the tension in lines 13 and 14 can be controlled individually by individually varying the flow of fluid through pipes 28 and 35, or by closing a valve between the cylinders, or after a cylinder has stroked out. However, if desired, hydraulic means 25 and 31 can be made to automatically balance the tensions in lines 13 and 14 to the same valve by simply interconnecting pipes 28 and 35 as shown by dotted lines representing interconnecting pipe 37. In this way movement of one power means is automatically balanced with the other power means thereby maintaining all lines on that leg under substantially the same tension load. For example, should the tension increase in line 13 thereby tending to move power means 13' downwardly against piston 27, this increased pressure will be transmitted from the interior of cylinder 26 through pipes 28, 37, and 35 to the interior of cylinder 32 giving a consequent upward thrust to piston 33 and power means 14' with the net result of automatically equalizing the tension between lines 13 and 14 following the initial increase in tension in line 13 alone. A similar automatic equalization results should line 13 come under less tension thereby tending to allow power means 13' to rise.

In the embodiment of interconnected hydraulic means it is important that the usable stroke length, for example, distance 38 in cylinder 32, exceeds the normal length of adjustment required to maintain constant tension in lines 13 and 14 under normal working conditions. This usable stroke length will vary widely depending upon the particular apparatus employed and therefore cannot be defined to a certainty, but one skilled in the art knowing of this requirement can readily design apparatus to accommodate the particular stroke length necessary to exceed the normal length adjustment which will be required to maintain constant tension in a given line. Thus, by interconnecting the hydraulic means around a given leg, the pressures in the interconnected hydraulic means will automatically be kept substantially equal thereby maintaining the tension in the lines for each of the power means carried by the interconnected hydraulic means substantially equal. It is obvious that this adjustment of tension among the plurality of lines employed in each leg is obtained without expensive and complicated control equipment and without substantial power requirements.

Further, as is often the case, more than two lines will be employed per leg of the platform and no matter how many lines are employed this invention can accommodate whatever number of lines are present without unduly enlarging the space or power requirements to obtain equalization of tension in the lines of each leg.

In the case where the lines are link chains, by selecting a sufficient stroke length 38 for the hydraulic means, it is possible to use a simple chain windlass stop means (lock pawl) which only allows locking the chain in position in units of full chain link lengths. By this invention, the length adjustment required after a chain link is locked by a pawl is accommodated by movement of the pistons in the hydraulic means.

Other devices which are functionally equivalent in this invention to the above described hydraulic means will be obvious to those skilled in the art and are intended to be within the scope of this invention.

Reasonable variations and modifications are possible within the scope of this disclosure without departing from the spirit and scope of this invention.

The embodiments of the invention in which an exclusive property and privilege is claimed are defined as follows:

1. In a tension-leg platform having a plurality of legs wherein each leg has a plurality of lines which connect to an anchor means, the improvement comprising a support means for each line, said support means being movably carried on said platform, a power means carried by each support means, said power means being associated with each line for retracting and paying out said line, individual hydraulic means mounted between said support means and said platform, said individual hydraulic means being independently movable so that each power means is essentially vertically movable relative to said platform, said essentially vertical movement of said power means being at least partially controlled by said individual hydraulic means, and for each leg the individual hydraulic means are interconnected with one another, whereby said movement of one power means on a given leg is automatically balanced with the other power means on that same leg thereby maintaining all lines on that leg under substantially the same tension load.

2. A platform according to claim 1 wherein said movement of each power means and therefore the tension in the line associated with that power means is

controlled by individual adjustment of the hydraulic means for that power means.

3. A platform according to claim **1** wherein each line is a cable.

4. A platform according to claim **3** wherein each power means is a winch and spool device.

5. A platform according to claim **1** wherein each line is a chain.

6. A platform according to claim **5** wherein each power means is a chain windlass.

7. A platform according to claim **1** wherein said hydraulic means each have a stroke length sufficient to cover anticipated adjustment lengths for maintaining the line associated with each power means under the necessary tension load.

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