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CHORD RESTRAINT SYSTEM
FOR USE WITH SELF ELEVATING DRILLING OR PRODUCTION RIGS, VESSELS OR PLATFORMS
(OIL & GAS INDUSTRY)

DESCRIPTION

Field of the Invention

This invention relates to the design of an apparatus and a method for providing restraint on the rack-chord, chord or surface of leg in self-elevating drilling or production rigs, vessels, platforms (**Unit)** used in oil and gas industry. Fundamentally, it is a different and innovative design and method enabling the reduction of stress in the leg structural members at the leg-hull interface. Not only is the design unique and innovative, the system as a whole is made portable or semi-portable, a concept never used before by similar or related systems such as the "Fixation system" or "Rack Chock system".

This invention, apart from performing its intended function for the Unit, is shareable among Units. Because its application is essentially different and more pragmatic in providing restraint on the leg rack-chord, leg chord or surface, the system is called "Chord Restraint System" to distinguish it from "Fixation system" or "Rack & Chock system" used in some current rig designs.

A typical Fixation or Rack-Chock system used in a self-elevating or jack-up drilling rig or platform is depicted in ***figure 1***. The following terminologies common in a Unit are defined below to assist in understanding the novel application of the CRS.

Terminology	Description
Leg	The self-elevating drilling rig, platform or equipment system stands on 'legs' that are firmly preloaded in sea bed. The number of legs can be 3 or more. Such legs are often made with a lattice structure.
Rack	The solid piece of steel plate cut to rack profile shaped with gear teeth.
Chord plate	The reinforcement plate to make the rack as a strong structural element integral with the Leg structure.
Pinion, Driving Pinion or Jacking system	The driving element is in the shape of a gear pinion, and is powered by electric or hydraulic motor through a gear-chain to reduce rotational speed and increase torque force in an assembled unit commonly known as the 'Jack Unit'.
Jack Case Structure	The structure connected to the body of the self-elevating drilling rig, vessel or platform to house the 'Pinion Assemblies' or 'Jacks' enabling the rig, platform, vessel or equipment system to self-elevate on the legs.
Fixation system	Typically known as the locking jaw with the leg rack element to hold and render the leg as an integral part of the rig body. It can fully or partially take over from the 'Jack Unit' in holding up the total weight of the elevated platform. Such a system is permanently fixed to the rig.
Rack Chock system	Typically known as the locking jaw with the leg rack element to hold and render the leg as an integral part of the rig body. It can fully or partially take over from the 'Jack Unit' in holding up the total weight of the elevated platform. Such a system is permanently fixed to the rig.

Power pack	The power system to support and drive the Fixation or Rack Chock system in order to operate it. It can be by means of hydraulic or electric.

Background of the Invention

Fixation or Rack-Chock system is commonly used in conjunction with current design of self-elevating drilling or production rigs, vessels or platforms (Unit). Its purpose is to 'lock' the legs with the Unit's hull so that they can be considered as one integral body therefore absorbing the leg bending moment substantially at this engagement location, and limiting force reactions at the chord as well as in the leg brace members thus reducing induced stress in these members.

Such apparatus described above and other variations of such design achieve their objective in reducing induced stress, therefore the leg structural scantling can then be reduced in design for specified weather and environmental conditions. In other words, the apparatus is then required to be applied most times, if not all times, This means it is a permanent fixture on the Unit. The operating limit of the Unit such as maximum operating water depth and weather conditions are defined as result of the application of the Fixation or Rack-Chock system.

A typical Fixation or Rack-Chock system is illustrated in ***figure 1.0***. It shows its 'dis-engaged' and 'engaged' positions. ***Figure 2.0*** shows the typical location of such a Fixation or Rack-Chock system on a Unit. The jack case or structure is normally designed to incorporate such a Fixation or Rack-Chock system.

Figure 3.0 shows, for a Fixation or Rack-Chock system permanently installed in a Unit, the mechanical and electrical outfits must also be permanently installed and distributed over the

Unit in order the system can be activated for each leg.. The whole operating and control system requires a central power pack to be installed somewhere in/on the rig. The same picture shows a network of outfits (piping, conduit, cables etc) reaching out to the three legs to operate the Fixation or Rack-Chock device for each leg chord.

The background of the Invention is to provide an alternative and novel design to reduce stress at the leg members at the leg-hull interface in a simpler manner while having several advantages.

First significant difference and substantial advantage of the present invention is that the engagement with the leg does not come in the typical fashion of rack tooth-to-tooth engagement. Instead, the contact or pressure surface on the CRS unitized engagement unit is a flat plane pushed against the tooth face over a few teeth of the rack (see ***Figure 5.0***) or as a variation, pushed against the chord surface or a combination of tooth-face and chord surface. It is designed so as not to have any vertical load carrying capacity except as horizontal load restraint ability. The weight of the elevated rig hull, vessel or platform is carried by the jack system (Jack Unit) pinions. The design of the CRS unitized engagement unit is simple and clearly an advantage in reducing manufacturing cost as well as in improving operation efficiency.

The second significant difference and substantial advantage of the present invention is that the simplicity and operation of the CRS unitized engagement unit allows it to be made as a modular item that is portable and can be installed with ease when the Unit requires it.

A third significant difference and substantial advantage of the present invention is that for each leg chord the CRS is to engage with, it does so in two separate locations on the chord (see ***Figure 4.0***). There is an upper fixture and a lower fixture. Typical Fixation or Rack Chock systems have their engaging fixture all in one location near the main deck of the Unit. This separate arrangement allows the bending moment at the lower guide to be absorbed with lesser

stress severity at the engagement area. This design concept also allows the fixtures to be lighter in each piece and this affords easier and better removal and handling. Notwithstanding, the invention does not preclude the adaptation of having the restraint occurring at one location or for that matter, at plurality of locations.

Fourth significant difference and substantial advantage of the present invention is that the design increases the availability of suitable material to make one essential part. In Fixation or Rack-Chock system, the engaging rack portion normally requires the material to be very thick (in the region ranging from 127mm (5in) to 178mm (7in) or more) and made of high strength steel having high yield and tensile strength. The application of the 'flat plane' pressure plate of the CRS unitized engagement unit is not limited to using steel as the material and it does not require to be made of very thick steel as it is subjected to only compression load and not shear load. Non-ferrous material with appropriate properties is an option for the construction of CRS pressure plate.

Fifth significant difference and substantial advantage of the present invention is that the Chord Restraint system (CRS) can operate with portable 'power pack'. This power pack is able to be moved to each leg and then worked to operate and engage the CRS unitized engagement units (see ***figure 7.0***). Once the CRS is applied to hold the leg chords of one leg, the power pack can then be carried away and be used for another leg until all 3 legs are held tightly to the Unit's hull by the CRS. By contrast, a centralized power pack system used in Fixation and Rack-Chock systems results in a network of distributed piping and electrical outfits (see ***figure 3.0***). Portable power pack used with CRS is a readily available item in the industry and is used to operate the CRS unitized engagement unit. It can work by means of electric power, hydraulic power, a combination of both and others. More than one portable 'power pack may be used if required.

Sixth significant difference and substantial advantage of the present invention is that on a Unit operating in a less severe environment not requiring CRS, CRS modular components can all be

removed and be used in another identical Unit which requires it (see ***Figure 7.0***). In this sense, CRS is totally portable and is distinctly innovative and different from Fixation or Rack Chock system. This sharing of CRS among identical Units is not only cost effective, but enhances the Unit's operational capability and flexibility.

In relation to the sixth point on significant difference and advantage, the **Chord Restraint system** (CRS) ultimately enhances the operational capability of the Unit. For a Unit originally designed for specified weather conditions without using any Fixation or rack-Chock system, the leg structural scantling will have been determined and sized accordingly. On adding the CRS, which effectively reduces stress in the leg structure under the same specified weather conditions, the Unit invariably becomes a stronger Unit to work in a harsher weather environment or is able to work in deeper water. To adapt the Unit and incorporate the CRS system, vis-a-vis Fixation or Rack-Chock system, the retrofit is obviously less complicated and much more cost effective. The application of CRS is then an 'add-on; system to enhance operational capability of the Unit. Alternatively, the CRS can be incorporated as an integral design on the Unit from the beginning and in this case, the CRS will become a fixed installation.

Needless to say a CRS design and invention optimizes apparatus utilization. As a result, cost savings in capital machinery expenditure is obvious as such a system can be shared among several Units rather than being fixed to a Unit.

The difference between a typical Fixation or Rack-Chock system and now the Chord Restraint system can be clearly observed by referring to ***Figures 2.0, 3.0, 4.0, 5.0, 6.0 and 7.0***

The Objective of the Invention

The objective of the invention is to provide an improved, alternative and innovative design to reduce stress in leg members of self-elevating/jack up rig, vessel or platform (the Unit) in the leg-hull interface region and to enhance the Unit's capability.

The CRS design will obviate or mitigate the aforementioned situation of high costs, construction/installation complexity, lack of usage optimization in the case of a Unit with Fixation or Rack-Chock system. CRS at least provides the public with a useful alternative and cost effective choice with several advantages.

Statement of the Invention.

The CRS works on rigidly preventing the leg chords to move in the direction of restraint once CRS unitized engagement units are applied by keeping the CRS contact or pressure plates hard pressed against the leg rack teeth faces, or chord surface, or a combination of the two on both sides of the rack. This application prevents the leg to come into hard contact with upper and lower guides thus eliminating the reactions that would occur at the leg-guide interface. The rack breadth of each rack-chord is situated normal to the leg triangle corners, and when a pair of CRS unitized engagement units are activated, the contact reactions cancel each other out thus preventing any reaction to be passed on to the braces interconnecting the chords. This action greatly reduces the induced stress in leg members, especially the braces (see ***figure 6.0***)

One-location restraint or multiple-location restraints using the CRS unitized engagement units per each leg chord are all part of the embodiment of this invention (see ***figure 4.0***)

The portability of CRS affords flexible usage with Unit which may or may not require CRS thus allowing the CRS to be used when it is truly needed. Because of this flexibility, the

invention immediately translates to cost savings and operation efficiency when compared with the conventional permanently installed Fixation or Rack Chock systems.

Results and Discussion

The following table highlights and compares the CRS advantages over typical Fixation or Rack-Chock systems. The table is in no way meant to be an exhaustive exploration of all of the features of the invention, and many of those not discussed will become readily apparent to a skilled reader once the full scope of the invention is understood.

No.	Features	Invention	Conventional
1.	Restraint plate is simple in design and does not need to be cut or shaped to rack profile and have large plate thickness	This immediately makes the material more readily available and easier to be produced	Engaging part of the fixation or Rack-Chock system has teeth profile of leg rack and is made with thick material, if not thicker than the rack.. This makes the item not cost effective and harder to manufacture.
2.	Designed for use to enhance the Unit's operating capabilities and not necessary a permanent feature	This makes the CRS to be installed only if there is a true requirement for its usage, as in the manner of harsher environmental conditions or deeper water depth for the unit to operate in. CRS thus potentially becomes a sharing system among Units to meet the occasional specific needs of	Fixation or Rack Chock system is designed to be permanently attached to a Unit thus making it not flexible and sharable with other Units.

		operation (see figure 6.0)	
3.	Portability	Because it is removable from a Unit when not required and usable on other Units requiring it, its portability brings the total cost of a Unit down when shared with other Units.	Capital expenditure of each Fixation and Rack-Chock system adds to the Unit's total cost,
4.	Portable Power Pack	This eliminates the fixed installation with distributed piping and electrical outfits to serve all three legs on a Unit. Cost saving is obvious not to mention lower maintenance demands (see ***Figure 7.0***)	A fixed system such as Fixation or Rack Chock system requires fixed installation of distributed piping and electrical outfits all over the Unit to serve the legs' Fixation or rack Chock systems.
5.	System operation ease	CRS unitized engaging units work in one direction to engage or disengage and not prior alignment is required as rack teeth engagement is not required	All Fixation or Rack-chock systems must have means to align vertically to ensure rack teeth engagement can be effectively done. This is due to different travel positions of the legs relative to the Unit's hull body (see ***figure 2.0***).

Modifications of the Preferred Embodiments

While the invention has been described with particular reference to certain embodiments thereof, it will be understood that various modifications can be made to the above-mentioned embodiment without departing from the spirit and scope of the present invention. The examples and the particular proportions set forth are intended to be illustrative only.

The skilled reader will instantly realize that, although the examples have been described for the 'Chord Restraint System' and in engagement with the legs with rack-chord elements of a self elevating Unit, these aforementioned descriptions are merely illustrative and will vary depending on the application and the requirements of the Unit. An example of such variation is application of CRS to the Unit's legs that are not made with racks or chords but other shape sections such as cylindrical, rectangular or something else.

Information Disclosure References

Information relating to inventions that may have been previously filed in by others and that is of similar invention can only be determined after a search by the authority

THE INVENTOR'S CLAIMS

1. A self elevating drilling or production rig, platform, vessel or system (the **Unit)** suitable for off-shore oil and gas drilling or production and other operations comprising:
a hull or body of the Unit to be moved up or down vertically by the Jacking system or Jack Unit ; and

at end of travel of the hull, a holding system commonly known as Fixation or Rack Chock system is used and often this relieves the Jack Unit from its function of holding up the hull fully or partially;

characterized in that the Fixation or Rack Chock system is now replaced by a Chord Constraint system (CRS) that is novel in design and performs to reduce stress in the leg members but does not relieve the Jack Unit from holding up the hull when the hull is stationary and,

further characterized in that the engagement works on a different, novel and unique principle of contact enabling the system to engage with the Unit's leg easily and,

further characterized in the simplicity in design which allows the engaging components to be modularized and installable as complete modular items.

2. A self elevating drilling or production rig, platform, vessel or system (the **Unit)** suitable for off-shore oil and gas drilling or production and other operations comprising:
a Fixation or Rack Chock system permanently installed and driven by a common or central power-pack to work the Fixation of Rack Chock systems at each leg of the Unit through a network of distributed piping and electrical outfits; and

a Fixation or Rack-Chock system as an integral part and not portable in any sense, and

a Fixation or Rack-Chock system which is certified with the Unit to work within the design operational capability limit;

characterized in that the CRS's Power Pack can be made portable to serve each leg at ease and therefore eliminates a substantive volume of distributed piping and electrical outfits that would otherwise be required for a central power pack system; and,

further characterized by that the whole CRS system and modular components are all an add-on portable system which can be dismounted or removed and be used in another Unit designed to work without the CRS but adaptable to incorporate the CRS; and

further characterized by that upon incorporating the CRS, the Unit receiving the CRS is now able to be certified to operate in harsher weather environment or in deeper water depth than it is designed for. CRS thus essentially enhances the Unit's original design operating capability limit,