

**MULTIPLE RACKS USED IN RACK AND PINION APPLICATION IN
MOVING OR SELF-ELEVATING SYSTEMS
(OFFSHORE & ONSHORE ENERGY SECTOR)**

DESCRIPTION

Field of the Invention

This invention relates to the design of an apparatus and a method for use in moving or self-elevating operations. This invention is applicable, though not exclusively, to self elevating drilling rigs, non-drilling platforms or vessels, moving as well as self-elevating equipment or system in both onshore and offshore applications. Fundamentally, it is a different and innovative design enabling a heavy physical body/object or system to be self-elevated or moved in linear or other motions. There is a requirement for the heavy physical object to weigh at least 200 metric tons. There is however, no maximum weight limit to this application.

The uniqueness of this invention enhances the construction of the moving or self-elevating system by providing wider options in constructing an “element”, without reducing the intended functionality of the system. This element refers specifically to the rack used as in ‘rack and pinion’ (referred hereinafter as “R & P”) of moving or self-elevating body or system.

A typical R & P system used in a self-elevating or jack-up drilling rig or platform is depicted in *figure 1*. The following terminologies are used for the better understanding of the system.

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.
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 Jack	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 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.

Background Of The Invention

R & P system is commonly used in self-elevating drilling rigs, vessels or platforms or in moving equipment or systems.

While the apparatus described above and other variations of such designs achieve their function of allowing self-elevation functions to be performed, the element of rack in the R & P remains as one solid rack metal engaging with the pinion.

The significant difference and substantial advantage of the present invention is that the rack element is now made up of **multiples of solid but thinner rack** in engagement with the pinion (hereinafter referred to as “MR & P”) to provide the same performance as in other R & P systems.

Needless to say an MR & P design optimizes the material availability, time and cost to construct such a rack element to be used in a R & P self-elevating or moving system.

The difference between a typical R & P system and now the MR & P system can be seen as depicted in *figures 2, 2a and 2b*. *Figure 2* shows a typical single solid rack system. *Figure 2a* shows typical design philosophy to achieve a ‘2-racks-as-one’ configuration, and *Figure 2b* for ‘3-racks-as-one’ configuration. More racks than 3 as one is feasible and still comes under the ambit of this invention.

Above *Figures 2, 2a and 2b* all show only half side of double sided single and multiple racks.

A cross section of a typical double sided rack fabricated between two half chord plates is depicted in following *Figure 2c*.

Figure 3 shows one construction method to achieve the ‘2-racks-as-one’ configuration. Other construction methods to achieve the same multiple-racks-as-one’ are possible, and shall come under the same invention as proposed herein.

Figure 4a shows another method of making ‘2 racks-as-one’ configuration.

Figure 4b shows a perspective view of ‘multi-racks-as-one’ engaging with a pinion.

The multiple-racks-as-one, when engaged with pinion driven by one Jack motor set, provides the basic system to finally enable the rig, platform or physical body to move relative to the rack. Such a contact by one pinion with the multiple racks-as-one can be termed as one ‘Engagement’.

When sufficient Engagements are provided, the driving pinions, being made integral with the rig hull through the jack house structures, will provide sufficient lifting or holding force to allow the rig hull to climb up or down the multiple racks.

In other applications, the same MR & P system can be used to provide motion between any two parts in directions other than vertical. For example, MR & P can be used in skidding system of the large physical bodies in the horizontal or inclined direction during load out operations and others.

The objective of the Invention

The objective of the invention is to provide an improved and innovative design to construct racks for R & P applications. The innovative MR & P system increases the availability of suitable material to make the rack, which normally requires the material to be of high strength steel having high yield and tensile strength and at the same time having appropriate impact properties to meet the R & P application. The application of MR & P system is not limited to using steel as the material.

The requirement for the high strength material to be sufficiently thick in just one single solid piece is not ideal, especially since steel mills in the world in general have limited production capabilities in such steel when the plate thickness exceeds a certain amount. This is because such thick and high strength steel plates are not always in constant demand and the setting up of a production line by a mill to cater only for the high demand that is often cyclic in long time period does not make economical sense. This is clearly seen in the current situation where the demand is more than the supply, hence resulting in the high costs of steel and long delivery dates for such thick and high strength steel material.

The MR & P design will obviate or mitigate the aforementioned situation of short supply, or one which will at least provide the public with a useful and cost effective choice, together with its flexibility in design.

Statement of the Invention.

The multiple pressure surfaces of rack teeth due to multiple racks-as-one, are able to absorb and withstand the load transmitted from the driving pinion of a jacking system on a self-elevating rig as though the multiple racks are made from a single solid thick plate.

Since the multiple rack plates are welded together first to form multiple layers before cutting to final tooth profile, the individual tooth-cut racks together will behave in 'stress-strain' manner to distribute the load and share it across the aggregate width or area of multiple racks, as in one solid and wide rack, in contact with each pinion. The dimensional tolerance as achieved during the cutting process determines an even stress distribution in ensuring the rack material allowable yield strength limit is not exceeded.

The end result is that such a multiple racks-as-one design and invention behaves the same, as in one solid and wide rack, in the ability to take on the pinion load of a self-elevating rig or platform. This design and invention is a cost effective and production friendly creation in a time of short supply of high strength thick steel plates.

Description of the Invention

This invention provides a unique manner to make a similar and typical element or component in the engagement of a moving or elevating rig, platform, vessel or system but allows thinner high strength steel racks to be used and be combined in multiples to provide the same effect and performance of the wider solid rack function.

The inventor has found that by making multiples of thinner rack plates to create the Engagement in a moving or self-elevating system, he is able to make the high strength material more easily available and cost effective in the event the thick high strength material is in short supply. Such an invention is able to support the construction of rigs without delay as caused by the scarcity of the thick and high strength material.

The scope of the invention extends to any novel moving and elevating system comprising such a MR & P system.

Results and Discussion

The following table highlights and compares the advantages over the existing R & P 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.	Multiple racks as one	This immediately makes the material more readily available and easier to be produced in mills.	Single solid rack requires special attention in mill production.
2.	Cost effective	Because thinner high strength steel or material is cheaper and mass produced, the cost effectiveness is obvious in time of scarcity of thick material availability.	The cost is highly dependent on thick material availability as it is not normally mass produced.
3.	Better stress distribution	Because the contact surface with the pinion is now taken by multiples of surface of lesser width, 'stress-strain' material behavior helps to distribute the stress more effectively.	A single solid surface becomes more rigid to respond to non-linear behavior and this can create highly stressed zones across the rack tooth width.
4.	Higher load handling possibility	Because the racks are in multiples, this can lead to inventive design on the pinion side to result in	To follow this attempt or design approach will incur difficulty and much higher costs as the basic constraint is

		stronger pinions to handle larger elevating loads.	still availability and costs of thicker materials.
--	--	--	--

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 'Multiple-Racks-as-One design' and in engagement with pinion for self elevating or other movement purpose (MR & P), these aforementioned descriptions are merely illustrative and will vary depending on the application and the requirements of the rig, platform, vessel or system to be moved in elevating or other directional manners. An example of such variation is using a single sided multiple racks as opposed to double sided multiple racks.

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 CLAIM

1. A drilling rig, platform, vessel or system suitable for off-shore oil and gas drilling and other operations comprising:
 - a hull;
 - a plurality of pinions;
 - a pinion driving system for driving at least one of the plurality of pinions; and
 - a plurality of legs, each of the plurality of legs having a plurality of rack chords extending therealong, each of the plurality of pinions for engaging one of the plurality of rack chords of one of the plurality of legs and being actuatable for spatially displacing the one of the plurality of legs relative to the hull,

characterized in that each of the plurality of rack chords is formed from a plurality of thinner racks.
2. A drilling rig, platform, vessel or system suitable for off-shore oil and gas drilling and other operations comprising:
 - a hull;
 - a leg movably coupled to the hull;
 - a rack chord extending along the leg; and
 - a pinion coupled to the hull and engaging the rack chord, the pinion being actuatable for traversing along the rack chord to thereby spatially displace the leg relative to the hull,

characterized in that the rack chord is formed from a plurality of thinner racks.

3. A leg for use in a drilling rig, platform, vessel or system suitable for off-shore oil and gas drilling and other operations comprising:
- a rack chord for engaging a pinion coupled to a hull,
 - characterized in that the rack chord is formed from a plurality of thinner racks,
 - wherein the pinion is actuatable for traversing along the rack chord to thereby spatially displace the leg relative to the hull.