Abstract: A casing hanger (300) for installation of a casing in a wellhead, and a method of fabricating a casing hanger are provided. The casing hanger comprising a slip bowl (306) defining a hollow centre portion; a plurality of slip segments (302) disposed within the hollow centre portion of the slip bowl and movable relative to the slip bowl for suspending the casing in the wellhead; a packing layer (308) disposed below the slip bowl; and a lower plate (310) disposed below the packing layer and coupled to the slip bowl for holding the packing layer (308); wherein the slip bowl comprises a plurality of recesses (402) on a bottom surface, and the packing layer (308) is configured to allow a plurality of protrusions (603) from the lower plate (310) corresponding to said recesses to pass through.
A CASING HANGER

FIELD OF INVENTION

The present invention relates broadly to a casing hanger for installation of a casing in a wellhead, and to a method of fabricating a casing hanger.

BACKGROUND

Wellheads are used in oil and gas drilling to suspend casing strings, seal the annulus between casing strings, and provide an interface to a blow out preventer ("BOP"). In drilling a well, it is a standard practice to pass a number of concentric tubes, or casings, down into the well to support the borehole and/or isolate the borehole from fluid producing zones. The wellhead is used to support a number of casing hangers that support the weight of the casing.

Figure 1 shows a cross-sectional view of a conventional slip-type casing hanger 100, hereinafter also referred to as slip hanger 100. Figure 2 shows a cross-sectional view of a wellhead 200 having the slip hanger 100 of Figure 1 disposed therein.

Typically, the functions of the slip hanger 100 include suspending one or more casing strings (not shown), and sealing off pressure from the annulus area 202 (Figure 2). In the slip hanger 100, slips 102, which are disposed adjacent a slip bowl 106 and a casing 204 (Figure 2), are friction wedges that "grip" the casing string and use "teeth" 104 to bite into the casing 204 when subjected to the weight of the casing 204. Seals, e.g. in the form of a deformable packing layer 108, are used to seal the annulus 202 between the casing 204 and the wellhead 200. For example, the packing layer 108 is made of a rubber ring and is disposed below the slips 102 and above a lower plate 110. When the slip hanger 100 is in use, the lower plate 110 rests inside the wellhead 200, and the packing layer 108 is compressed by the downward casing weight that is first transferred to the slips 102 then to the packing layer 108. As the packing layer 108 expands laterally under the weight, it seals the annulus 202 between the casing 204 and the wellhead 200.
There are several drawbacks with the existing packing and seal configuration described above. For example, in some instances, the slip hanger 100 may become stuck onto the casing 204, resulting in large amounts of remedial work to correct. In addition, with the position of the packing layer 108 below the slips 102, hanging capacity is limited, as the packing layer 108 may be compressed above its compressible ratio. Thus, the conventional slip hanger 100 may not be suitable for high load and high pressure applications where the packing layer 108 may become over compressed and extruded. Test results on a standard 7-inch casing hanger have shown that it fails to hold at a pressure of 10,000 pound per square inch (psi) with a 800,000 pound-force (lbf) casing load under temperatures of -20° to 350°F.

A need therefore exists to provide a slip hanger that seeks to address at least one of the above problems.

SUMMARY

In accordance with a first aspect of the present invention, there is provided a casing hanger for installation of a casing in a wellhead, the casing hanger comprising a slip bowl defining a hollow centre portion; a plurality of slip segments disposed within the hollow centre portion of the slip bowl and movable relative to the slip bowl for suspending the casing in the wellhead; a packing layer disposed below the slip bowl; and a lower plate disposed below the packing layer and coupled to the slip bowl for holding the packing layer; wherein the slip bowl comprises a plurality of recesses on a bottom surface, and the packing layer is configured to allow a plurality of protrusions from the lower plate corresponding to said recesses to pass through.

The packing layer may be compressible between the slip bowl and the lower plate such that the protrusions from the lower plate protrude into the corresponding recesses on the slip bowl when the packing layer is compressed.

The lower plate may be configured to directly contact with the slip bowl before a compression capacity of the packing layer is reached.

A top face of the protrusions may be configured to contact with a bottom face of the corresponding recesses.
The packing layer may expand laterally when compressed for sealing an annular space between the casing and the wellhead.

The packing layer may comprise through slots corresponding to the protrusions for allowing the protrusions to pass.

The volume of the packing layer in an unloaded state may be about 1.10 times the volume of the packing layer when lower plate directly contacts with the slip bowl.

The lower plate may be coupled to the slip bowl by a plurality of socket screws such that the screws are moveable relative to the slip bowl.

The casing hanger may comprise two equal halves coupled to each other by fastening means.

In a deployed state, the lower plate may abut a shoulder of the wellhead for transferring the casing weight to the wellhead.

The slip segments each may comprise inner teeth for engaging with the casing, and outer teeth for engaging with the slip bowl.

The slip segments may be connected and aligned to each other by alignment means.

In accordance with a second aspect of the present invention, there is provided a method of fabricating a casing hanger, the method comprising the steps of providing a slip bowl having a hollow centre portion a plurality of recesses on a bottom surface; disposing a plurality of slip segments within the hollow centre portion of the slip bowl such that the slip segments are movable relative to the slip bowl; assembling a packing layer to a lower plate by allowing a plurality of protrusions from the lower plate to pass through the packing layer; and coupling the lower plate and the packing layer below the slip bowl such that the packing layer is between the slip bowl and the lower plate, and the protrusions correspond to the recesses on the slip bowl.

BRIEF DESCRIPTION OF THE DRAWINGS
Embodiments of the invention will be better understood and readily apparent to one of ordinary skill in the art from the following written description, by way of example only, and in conjunction with the drawings, in which:

Figure 1 shows a cross-sectional view of a prior art slip-type casing hanger.

Figure 2 shows a cross-sectional view of a prior art wellhead having the slip hanger of Figure 1 disposed therein.

Figure 3 shows a cross-sectional view of a slip-type casing hanger according to an example embodiment.

Figure 4 shows an inverted perspective view of a slip bowl used in the slip hanger of Figure 3 according to an example embodiment.

Figure 5 shows a perspective view of a packing layer used in the slip hanger of Figure 3 according to an example embodiment.

Figure 6 shows a perspective view of a lower plate used in the slip hanger of Figure 3 according to an example embodiment.

Figure 7 shows a cross-sectional view of a wellhead including a bowl.

Figure 8 shows a cross-sectional view of the wellhead of Figure 7 together with a casing inserted therein.

Figure 9 shows a cross-sectional view illustrating the assembly of the casing hanger of the example embodiments around the casing.

Figure 10a shows a cross-sectional view of casing hanger of the example embodiments in a wellhead when the casing is externally supported.

Figure 10b shows a cut-away perspective view of the casing hanger and wellhead of Figure 10a.

Figure 10c shows an enlarged view of a detail A of Figure 10b.

Figure 11a shows a cross-sectional view of casing hanger of the example embodiments in a wellhead when the casing is no longer externally supported.

Figure 11b shows a cut-away perspective view of the casing hanger and wellhead of Figure 11a.

Figure 11c shows an enlarged view of a detail A of Figure 11b.

Figure 12 shows a cross-sectional view illustrating insertion of external lockdown screws to the slip hanger of the example embodiments.

Figure 13 shows a cross-sectional view of the wellhead after the assembly process is completed according to an example embodiment.
Figure 14 shows a flow chart illustrating a method of fabricating a casing hanger according to an example embodiment.

**DETAILED DESCRIPTION**

Example embodiments provide a slip-type casing hanger which incorporates a wrap-around slip and seal assembly. The slip and seal assembly can be fully integrated in the casing hanger with a suitable hinging means, and after construction, requires no further assembly during installation procedures other than to engage the casing. Moreover, the slip hanger in the example embodiments is a weight-energized casing hanger which has a sealing mechanism disposed below the slip segments to activate sealing when loaded with the casing.

Figure 3 shows a cross-sectional view of a slip-type casing hanger 300, hereinafter also referred to as slip hanger 300, according to an example embodiment. In this view, the slip hanger 300 is upright in the same orientation as its orientation during normal deployment. The slip hanger 300 includes slip segments 302 (hereinafter also referred to as slips 302), which have inner teeth 304 for gripping a cylindrical casing (not shown) passing through its hollow centre. The slips 302 are disposed inside of a slip bowl 306, similar to a conventional slip hanger, and outer teeth 305 of the slips 302 contact with an inner surface 307 of the slip bowl 306. As would be appreciated by a person skilled in the art, the slip segments 302 may be moveable, at some resistance due to the outer teeth 305 contacting the surface 307, relative the slip bowl 306. For example, slips 302 may slide downward due to the casing weight, thereby tightening their grip on the casing. The slips 302 may be made of normalized alloy steel, e.g. American Iron and Steel Institute (AISI) 8620, while the slip bowl 306 may be made of alloy steel, e.g. AISI 4130. It is understood that other materials may also be used.

In addition, the slip hanger 300 may further include a packing layer 308 disposed below the slips 302 and the slip bowl 306, and a lower plate 310 disposed below the packing layer 308. In this embodiment, the lower plate is configured to rest on a shoulder of a wellhead (not shown) when deployed. The packing layer 308 can be made of an elastic material such as rubber, while the lower plate may be made of low alloy steel, e.g. AISI 4130. It is understood that other materials may also be used in alternate embodiments. As will be described in detail with respect to Figures 5 and 6, the packing layer 308 is configured to be sufficiently compressed laterally under load, e.g. due to the weight of the casing, to provide sealing effects, while allowing the weight of the casing to be transferred directly to the lower plate 310. In some embodiments, fastening means, e.g. in the form of socket-head
screws 312, are used to secure the slip bowl 306 to the lower plate 310. Only the bottom end of each screw 312 is threaded and engages with the lower plate 310 thereby preventing the lower plate 310 is from falling off the slip bowl 306, while allowing relative movement between the slip bowl 306 and the lower plate 310 when the packing layer 308 is compressed.

As described, the slip hanger 300 forms a hollow cylinder capable of gripping a casing running through its center, as well as resting on a shoulder of the wellhead. The slip hanger 300 thus helps to suspend the casing inside the bore hole. Typically, the slip hanger 300 is formed of two equal halves joined by fastening means e.g. screws 314 or other mechanical fasteners. The screws 312 and 314 may be made of quenched and tempered alloy steel, e.g. A193 B7. Components for each half are assembled first before the two halves are joined.

Figure 4 shows an inverted perspective view of the slip bowl 306 used in the slip hanger 300 of Figure 3 according to an example embodiment. The slip bowl 306 may be made of two equal halves, which define a hollow centre portion 401 when assembled for holding the slip segments 302 (Figure 3). An external side surface 410 of the slip bowl 306 is substantially cylindrical. As can be seen in Figure 4, the slip bowl 306 includes a plurality of recesses 402a-d on a bottom surface 403, capable of receiving respective protrusions from the lower plate 310 (Figure 3), as will be described in detail with respect to Figure 6. The depth of the recesses 402a-d is chosen such that the top faces 603a-d (Figure 6) of the protrusions contact respective faces 405a-d before the packing layer 308 (Figure 3) becomes over-compressed, as discussed below with respect to Figure 11c. In preferred embodiments, the recesses 402a-d have the same size and are evenly spaced on the bottom surface 403. The recesses 402a-d include respective through holes 404a-d for receiving respective screws 312 (Figure 3). The through holes 404a-d are not threaded to allow the screws 312 to move up and down as required. Openings 406, 408 are provided on the slip bowl 306 for mounting screws 312, 314 (Figure 3) respectively.

Figure 5 shows a perspective view of the packing layer 308 used in the slip hanger 300 of Figure 3 according to an example embodiment. The packing layer 308 may be made of two equal halves which define a hollow centre portion 501 and an annular portion 503. In addition, the packing layer 308 includes a plurality of slots 502a-d, which have the same size and are evenly spaced on the annular portion 503, capable of receiving the respective protrusions 602a-d from the lower plate 310, as will be described in details with respect to Figure 6. The outer surface 504 and inner surface 506 of
the annular portion 503 are substantially cylindrical, while the top surface 508 of the annular portion 503 is substantially flat.

Figure 6 shows a perspective view of the lower plate 310 used in the slip hanger 300 of Figure 3 according to an example embodiment. As described, the lower plate 310 may be made of two equal halves and includes a plurality of protrusions 602a-d on a top surface 601. In preferred embodiments, the protrusions 602a-d are of same size and are evenly spaced on the top surface 601. In one example implementation, the height of the protrusions 602a-d is about 1.24 inches (3.15 cm) and is equal to the uncompressed thickness of the packing layer 308 (Figure 3 and 5). Top faces 603a-d of protrusions 602a-d are typically flat and include respective threaded holes 604a-d for receiving respective threaded ends of screws 312 (Figure 3). It will be appreciated that other configurations or fasteners that allow that lower plate 310 to be coupled to the slip bowl 306 while allow movement of the lower plate relative to the slip bowl 306 can be used in alternate embodiments. Outer surface 606 and outer surface 608 of the lower plate 310 are substantially cylindrical.

While four protrusions 602a-d are shown in Figure 6, it will be appreciated that a different number of protrusions may be used in alternate embodiments, although an even number is preferred when the lower plate 310 is made of two equal halves. In alternate embodiments, the numbers of recesses 402 (Figure 4) and slots 504 (Figure 5) may be changed accordingly.

Referring to Figures 4-6, to assemble one half of the slip hanger 300, one half of the lower plate 310 is assembled onto one half of the packing layer 308 by inserting the protrusions 602 into the corresponding slots 502. Separately, the slips 302 and one half of the slip bowl 306 are also assembled together. The two sub-assemblies are then joined by fastening screws 312, which can be provided via opening 406.

With reference to Figures 7-13, the deployment of the slip-type casing hanger 300 (Figure 3) for installation of a casing in a wellhead is now described. Here, the same numerals are used to denote the respective elements already described in previous Figures.

In the first step, a well head is prepared. In some instances, lock down screws (not shown) need to be retracted in this step. Figure 7 shows a cross-sectional view of a wellhead 700 including a bowl 702.
In the second step, a casing string (also referred to as casing) is run (i.e. lowered) to the required depth in the bore hole. Figure 8 shows a cross-sectional view of the wellhead 700 together with a casing 802 inserted therein. At this point, the casing 802 is suspended by a block from above a rig floor (not shown).

In the next step, the slip-type casing hanger 300 is assembled around the casing 802. Figure 9 shows a cross-sectional view illustrating the assembly of the casing hanger 300 of the example embodiments around the casing 802. Supporting boards 902, which are typically made of wood, are placed on top of the wellhead 700. The casing hanger 300 is split open and placed above the supporting boards 902, which prevents the hanger 300 from dropping uncontrollably into the bore hole. The two halves of the hanger 300 engage the casing 802 such that the inner teeth 304 (Figure 3), the inner surface 506 of the packing layer 308 (Figure 5) and the inner surface 608 of the lower plate 310 are adjacent, but movable relative to, the casing 802. The two halves are then locked to each other by fastening screws 314. As can be seen in Figure 9, the slips 302 are connected and aligned to each other using, for example, alignment means in the form of pins 904. The casing hanger 300 is then lifted using a plurality of lifting T-bars 906. In one implementation, 4 T-bars 906 of 3/8 UNC thread are used for lifting the casing hanger 300.

Next, the supporting boards 902 are removed and the slip hanger 300, which now wraps around a portion of the casing 802, is lowered into the bowl 702 of the wellhead 700. Figure 10a shows a cross-sectional view illustrating a resting position of the slip hanger 300 in the bowl 702. In this position, a chamfered surface 1010 of the lower plate 310 abuts a wellhead shoulder 1001 and is prevented from dropping further. Typically, the wellhead shoulder 1001 is slanted at an angle, e.g. 45°, corresponding to the chamfered surface 1010 of the lower plate 310. Once the slip hanger 300, is in the resting position shown in Figure 10, the lifting T-bars 906 are detached. In some implementations, the casing 802 may be pulled upward slightly to initiate the slips 302 to slide downward and start contact with the casing 802.

Figure 10b shows a cut-away view of the wellhead 700 shown in Figure 10a, with the slip hanger 300 in its resting position and the T-bars 906 detached. Figure 10c shows an enlarged view of a detail A of Figure 10b. At this point, the casing 802 is still suspended by external means (not shown), thus no external weight acts on the slip hanger 300 and the slips 302 are not yet activated. As can be seen in Figure 10c, a protrusion 1002 of the lower plate 310 is accommodated within a corresponding slot 1003 of the packing layer 308, without protruding into a corresponding recess 1004 of the slip bowl 306. In one example implementation/ the height of the protrusion is about 1.24 inches, which is equal to an uncompressed
thickness T1 of the packing layer 308. Also, at this point, a screw head 1006 of the screw 312 is in contact with a face 1008 of the opening 406.

Next, the casing 802 is released from the external suspension means and allowed to travel vertically downward due to its own weight. As a result, the slips 302 are dragged downward relative to the slip bowl 306, and in the process, its inner teeth 304 "bite" into the casing 802 for suspending the casing. Additionally, as the slips 302 are in cooperative contact with the inner surface 307 of the slip bowl 306 via outer teeth 305 (Figure 3), the slip bowl 306 is also pushed downward to compress the packing layer 308.

Figure 11a shows a cross-sectional view illustrating the slip hanger 300 in an energised (i.e. loaded) state inside the wellhead 700 according to an example embodiment. Figure 11b shows a cut-away perspective view of the wellhead 700 shown in Figure 10a, with the slip hanger 300 under the casing load. Figure 11c shows an enlarged view of a detail A of Figure 11b.

As can be more clearly seen in Figure 11c, the packing layer 308 is compressed due to the casing weight that is transferred via the slips 302 and the slip bowl 306. As a result, the packing layer 308, being made of an elastic material, expands laterally and seals the gaps between the casing and the slip hanger 300, and between the slip hanger 300 and the well head 700. In one example implementation, the compressed thickness T2 at this point is about 1.09 inches (2.77 cm). Moreover, as the lower plate 310 cannot move downward, the protrusion 1002 of the lower plate 310 now partially protrudes into the recess 1004 of the slip bowl 306 due to the downward movement of the slip bowl 306. For example, based on the difference between initial thickness T1 and compressed thickness T2, the protrusion into the recess 1004 at this point is about 0.16 inches (0.41 cm). The screw head 1006 of the screw 312 is no longer in contract with the face 1008 of the opening 406, as the screw 312 is free to move relative to the slip bowl 306.

In embodiments where the weight of the casing 702 is large, the packing layer 308 may be compressed to the extent that the protrusion 1002 abuts the face 405 of the recess 1004. In other words, the slip bowl 306 has moved sufficiently downward to directly contact with the protrusion 1002 of the lower plate. Thus, the casing weight is transferred from the slips 302 and slip bowl 306 directly to the lower plate 310, without over-compressing the packing layer 308. As the lower plate 310 rests on the wellhead shoulder, this weight is eventually transferred to the wellhead 700. The depth D of the recess 1004 is chosen to allow the protrusion 1002 to contact the face 405 before the packing layer reaches a predetermined compression ratio. In a preferred embodiment, Hydrogenated Nitrile Butadiene Rubber (HNBR) with a Duro hardness of 80 may be used for the packing layer 308. The volume of the packing
layer 308 before compression may be about 1.10 times the volume after it has been fully compressed (i.e. when the protrusion 1002 abuts the face 405 of the recess 1004). The depth of the recess 1004 and the height of the protrusion 1002 may be calculated based on the above volume ratio of 1.10, and geometry of the recess 1004 and protrusion 1002. For example, the depth \( D \) may be one-third of the value of thickness \( T \) (which is equal to the height of the protrusion 1002) in some implementations. It will be appreciated that the depth to thickness ratio may be different in alternate embodiments depending on e.g. the number of recesses/protrusions and their geometry, as long as the volume ratio of 1.10 is maintained. In other embodiments, a different volume ratio may be used. As the casing load is transferred on to the lower plate 310 then to the wellhead 700, the hanging capacity/casing load is not limited by the packing compression ratio (capacity).

In some embodiments, additional energisation may be externally provided to the slip hanger 300 (Figure 3). Figure 12 shows a cross-sectional view illustrating insertion of external lockdown screws 1202a, 1202b to the slip hanger 300. The lockdown screws 1202a, 1202b include external threads (not shown) that engage with internal threads (not shown) of respective holes 1204a, 1204b. Ends 1206a, 1206b of respective threads 1202a, 1202b are chamfered, e.g. at about 45°, and configured to abut corresponding chamfered faces 1208a, 1208b of the slip bowl 306 (Figure 3). By tightening the lockdown screws 1202a, 1202b, the slip bowl 306 is pushed downward and toward the casing 802. As a result, the packing layer 308 (Figure 3) is further compressed, thereby enhancing sealing effects, and the slips 302 (Figure 3) are further pressed against the casing 802, thereby enhancing grip thereon. The lockdown screws 1202a, 1202b are similar to conventional lockdown screws. In the example embodiments, the vertical level of the holes 1204a, 1204b is determined based on the position of the slip bowl 306 after under the casing load.

Figure 13 shows a cross-sectional view of the wellhead 700 (Figure 7) after assembly process is completed according to an example embodiment. A cover 1302 is attached to the wellhead 700, e.g. by way of fastening means 1304, and sealing means 1308, 1310 are disposed in the interfaces between the cover 1302 and the wellhead 700, and the cover and the casing 802, respectively, to provide additional sealing of annular space 1306.

The example embodiments as described provide a casing hanger in which protrusions of the lower plate can match with and extend into respective recesses of the slip bowl. Initially, the casing load helps to compress packing layer in order to achieve sealing of the annular gaps. When the casing load is higher than the capacity (compression ratio) of the packing, this load is taken by the protrusions of lower plate and transferred to the wellhead. As a result, the packing layer may not be "over compressed" in the
example embodiments, as the casing load larger than required to compress the packing layer is advantageously transferred to the wellhead. Embodiments of the present invention can provide an increase of up to 34-40% in the ability to sustain pressure and transfer load.

Figure 14 shows a flow chart 1400 illustrating a method of fabricating casing hanger according to an example embodiment. At step 1402, a slip bowl having a hollow centre portion a plurality of recesses on a bottom surface is provided. At step 1404, a plurality of slip segments are disposed within the hollow centre portion of the slip bowl such that the slip segments are movable relative to the slip bowl. At step 1406, a packing layer is assembled to a lower plate by allowing a plurality of protrusions from the lower plate to pass through the packing layer. At step 1408, the lower plate and the packing layer are coupled below the slip bowl such that the packing layer is between the slip bowl and the lower plate, and the protrusions correspond to the recesses on the slip bowl.

It will be appreciated by a person skilled in the art that numerous variations and/or modifications may be made to the present invention as shown in the specific embodiments without departing from the spirit or scope of the invention as broadly described. The present embodiments are, therefore, to be considered in all respects to be illustrative and not restrictive.
CLAIMS

1. A casing hanger for installation of a casing in a wellhead, the casing hanger comprising:
   a slip bowl defining a hollow centre portion;
   a plurality of slip segments disposed within the hollow centre portion of the slip bowl and movable relative to the slip bowl for suspending the casing in the wellhead;
   a packing layer disposed below the slip bowl; and
   a lower plate disposed below the packing layer and coupled to the slip bowl for holding the packing layer;

   wherein the slip bowl comprises a plurality of recesses on a bottom surface, and the packing layer is configured to allow a plurality of protrusions from the lower plate corresponding to said recesses to pass through.

2. The casing hanger as claimed in claim 1, wherein the packing layer is compressible between the slip bowl and the lower plate such that the protrusions from the lower plate protrude into the corresponding recesses on the slip bowl when the packing layer is compressed.

3. The casing hanger as claimed in claim 2, wherein lower plate is configured to directly contact with the slip bowl before a compression capacity of the packing layer is reached.

4. The casing hanger as claimed in claim 3, wherein a top face of the protrusions is configured to contact with a bottom face of the corresponding recesses.

5. The casing hanger as claimed in claim 2, wherein the packing layer expands laterally when compressed for sealing an annular space between the casing and the wellhead.

6. The casing hanger as claimed in any one of the preceding claims, wherein the packing layer comprises through slots corresponding to the protrusions for allowing the protrusions to pass.

7. The casing hanger as claimed in claim 3, wherein the volume of the packing layer in an unloaded state is about 1.10 times the volume of the packing layer when lower plate directly contacts with the slip bowl.
8. The casing hanger as claimed in any one of the preceding claims, wherein the lower plate is coupled to the slip bowl by a plurality of socket screws such that the screws are moveable relative to the slip bowl.

9. The casing hanger as claimed in any one of the preceding claims, comprising two equal halves coupled to each other by fastening means.

10. The casing hanger as claimed in any one of the preceding claims, wherein, in a deployed state, the lower plate abuts a shoulder of the wellhead for transferring the casing weight to the wellhead.

11. The casing hanger as claimed in any one of the preceding claims, wherein the slip segments each comprises inner teeth for engaging with the casing, and outer teeth for engaging with the slip bowl.

12. The casing hanger as claimed in any one of the preceding claims, wherein the slip segments are connected and aligned to each other by alignment means.

13. A method of fabricating a casing hanger, the method comprising the steps of:
    providing a slip bowl having a hollow centre portion a plurality of recesses on a bottom surface;
    disposing a plurality of slip segments within the hollow centre portion of the slip bowl such that the slip segments are movable relative to the slip bowl;
    assembling a packing layer to a lower plate by allowing a plurality of protrusions from the lower plate to pass through the packing layer; and
    coupling the lower plate and the packing layer below the slip bowl such that the packing layer is between the slip bowl and the lower plate, and the protrusions correspond to the recesses on the slip bowl.

30
1400

Figure 14

1402

providing a slip bowl having a hollow centre portion a plurality of recesses on a bottom surface

1404

disposing a plurality of slip segments within the hollow centre portion of the slip bowl such that the slip segments are movable relative to the slip bowl

1406

assembling a packing layer to a lower plate by allowing a plurality of protrusions from the lower plate to pass through the packing layer

1408

coupling the lower plate and the packing layer below the slip bowl such that the packing layer is between the slip bowl and the lower plate, and the protrusions correspond to the recesses on the slip bowl
**INTERNATIONAL SEARCH REPORT**

**A. CLASSIFICATION OF SUBJECT MATTER**

INV. E21B33/04

**ADD.**

According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)

E21B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

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**Date of the actual completion of the international search**

3 January 2013

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