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Declarations under Rule 4.17:

— *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))*

— *of inventorship (Rule 4.17(iv))*

[Continued on next page]

(54) Title: SLIP ASSEMBLY

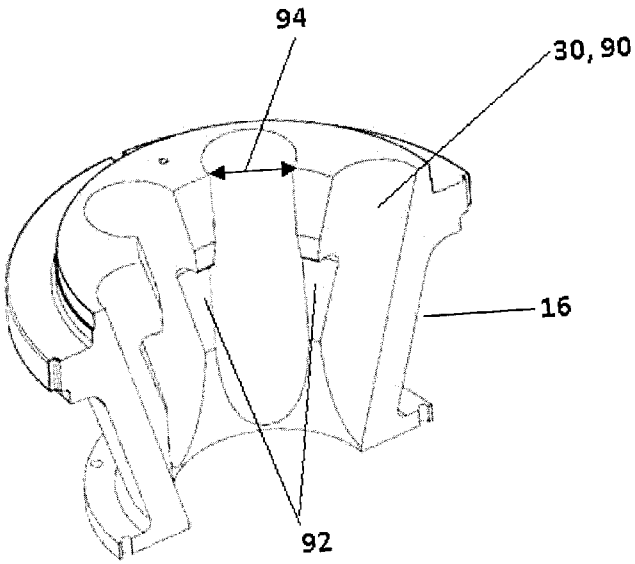

Figure 1

(57) Abstract: A gripping system is taught for gripping oil well casing, casing string or other string comprising one or more slips cammed against one or more inclined recesses when the gripping system is rotated to maintain gripping engagement of the casing. A further gripping system is taught for gripping oil well casing, casing string or other string comprising one or more slips received into one or more inclined recesses. A method is taught for gripping casing sections or casing strings. The method comprises the steps of providing a gripping system comprising one or more recesses and one or more slips, setting said one or more slips on the casing section and rotating the gripping system to cam said one or more slips against said one or more inclined recesses, wherein camming said one or more slips against said one or more inclined recesses serves to maintain gripping engagement on the casing. A further method is taught for gripping casing sections or casing strings. The method comprises the steps of receiving a slip into each of one or more inclined recesses of a gripping system, setting said one or more slips on the casing section and rotating the gripping system.

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Slip Assembly

Field of the Invention

The present invention relates to a slip assemblies and methods for gripping casing joints and casing strings.

Background

Slip assemblies are well known in the down-hole drilling and oil and gas industry. Slip assemblies are used to grip casing sections or strings, also called tubulars or piping, for a number of purposes including drilling, making up or breaking out casing strings and performing operations to produce oil from the well. Casing strings are made up by connecting multiple threaded casing sections together and feeding them into the wellbore. Rotation of a first casing into a second casing is conducted until the thread male and female ends engage one another.

The gripping mechanism of the slip assembly must be able to carry large loads and in certain operations including make up or break out operations do so while rotationally gripping the casing section or casing string. The components of the slip assembly must also cooperate to set and unset with ease and to maintain a fully set position on the casing section or casing string during torqueing and rotation.

While a number of prior art patents including US 6,631,792, US 7,891,469 and US 7,775,270 teach slip assemblies with means of guiding a slip into engagement with a casing section. However these patents do not address means of maintaining gripping of the casing during rotation and torqueing of the slip assembly for any number of operations including casing make up and break out or any operation involving rotation and torqueing where axial loads may exist.

A need and interest therefore exists in the art to develop improved slip assemblies and gripping systems and methods for making up casing strings.

Summary

A gripping system is taught for gripping oil well casing, casing string or other string comprising one or more slips cammed against one or more inclined recesses when the gripping system is rotated to enhance gripping engagement of the casing.

A further gripping system is taught for gripping oil well casing, casing string or other string comprising one or more slips received into one or more inclined recesses.

A method is taught for gripping casing sections or casing strings. The method comprises the steps of providing a gripping system comprising one or more recesses and one or more slips, setting said one or more slips on the casing section and rotating the gripping system to cam said one or more slips against said one or more inclined recesses, wherein camming said one or more slips against said one or more inclined recesses serves to enhance gripping engagement on the casing.

A further method is taught for gripping casing sections or casing strings. The method comprises the steps of receiving a slip into each of one or more inclined recesses of a gripping system, setting said one or more slips on the casing section and rotating the gripping system.

Brief Description of the Drawings

The present invention will now be described in greater detail, with reference to the following drawings, in which:

Figure 1 is an isometric view of a part of the slip assembly of the present invention;

Figure 2 is an isometric view of further parts of the slip assembly of the present invention;

Figure 3 is an isometric view of yet further parts of the slip assembly of the present invention;

Figure 4 is an isometric view of yet further parts of the slip assembly of the present invention; and

Figure 5 is a top plan view of one embodiment of the present slip assembly.

Description of the Invention

The slip assembly of the present invention, also called a gripping system can be used in conjunction with a number of tools known in the field of oil well completion and production. These tools include but are not limited to elevators, spiders, flush mount spiders, snubbing tools, bucking units and back up tongs. The present slip assemblies can be used in relation to any operations involving hoisting and rotation of a casing string or casing section or in any operation in which a casing string, casing section or tubular of any kind is torqued or rotated while under axial loading forces. These operations include but are not limited to casing make up or break out "drilling with casing", snubbing operations and horizontal wellbore operations.

The slip assemblies of the present invention are preferably actuated by one or more cylinders (not shown) that extend to set one or more gripping members of the slip assembly and retract to release said gripping members. Other means of actuation are also possible and would be understood by a person of skill in the art to be encompassed by the scope of the present invention

The present slip assembly or gripping system 14 is now described with references to Figures 1 to 5.

The seat 16 of the gripping system 14 preferably comprises an array of one or more separate inclined elements 30 for receiving slips 18.

In a further preferred embodiment, the inclined elements 30 comprise one or more integral or non-integral means of laterally retaining the slips 18 in the inclined elements 30, in such a way that the slips 18 are prevented from falling or tipping towards a central bore of the casing gripping system 14. Examples of non-integral retaining means include but are not limited to strips, plates, clips, cages, bars, tabs and rings that can be removably attached to at least a portion of the slip 18 and at least a portion of the seat 16 to laterally retain the slip 18 to the inclined element 30. Integral retaining means can include but are not limited to mating profiles on at least a portion

of the slip 18 and on at least a portion of the inclined elements 30 that connect to hold the slip 18 to the inclined element 30; such mating profiles can include shiplap profiles, tongue-and-groove profiles, dovetail profiles or other profiles well known in the art.

As seen in Figures 1 and 2, the inclined elements 30 can more preferably be in the form of an array of one or more inclined recesses 90 that correspond to a rear face 32 of the slips 18, thereby generating radially inward movement of the slips 18 to grip the casing joint 10 as the slips 18 are disposed longitudinally within inclined recesses 90, without the need for separate tracks, cam followers, springs or other means.

Preferably, the inclined recesses 90 have a cylindrical geometry and part-circular cross section to match a cylindrical geometry and part circular cross section of the slips 18. It is also possible for the inclined recesses 90 and slips 18 to have cross sections that are partial rectangles, partial squares, partial ovals, partial rhomboids and partial triangles or other cross-sectional geometries.

In a preferred embodiment, the inclined recesses 90 can comprise an integral retaining means along at least a portion of the axial length of the inclined recess 90. In one example, at least a portion of longitudinal edges 92 of the inclined recesses 90 comprise an integral throat, tab or strip that act to restrict the size of the mouth 94 of the inclined recess 90, to thereby capture slips 18 and laterally retain slips 18 from falling or tipping into the central bore of the seat 16.

In a further preferred embodiment, the inclined recesses 90 are machined to a cross sectional geometry that restricts the mouth 94 of the inclined recesses 90 to be smaller than the widest cross section of the slip 18. In this embodiment the recesses 90 function to partially circumferentially capture the slips 18. To effect this embodiment, at least a portion of the axial length of the inclined recesses 90 is machined such that the desired cross sectional geometry converges to restrict mouth 94. In the preferred case of a partial circle cross-section, at least a portion of the axial length of the inclined recess 90 is formed as more than half of a circle, otherwise put, more than a semi-circle, to provide a restriction to mouth 94 such that the slip 18 cannot fall into the central bore of the seat 16.

In a preferred embodiment of the present invention, the slips 18 and the recesses 90 interact in such a way as to enhance gripping forces on the casing section 10 during rotation. In a preferred embodiment, the slips 18 are caused to cam or wedge into the recesses 90 to thereby maintain a firm penetration of the dies 20 in the slips 18 and a firm grip of the outer surface of the casing section 10 by the dies 20 during casing make up or break out operations.

Most preferably slips 18 are nominally smaller in cross section than inclined recesses 90. When the slips 18 and dies 20 of the present gripping system 14 are set on the casing section 10 to be made up, the top drive is rotated to rotate gripping system 14. During rotation, gripping torque causes the slightly smaller slip 18 to advantageously rotate slightly. This results in a line of force in which the dies 20 are forced into a front face 36 of the slips 18, in turn forcing a rear face 32 of the slip to cam into and against the inclined recesses 90. This serves to further frictionally arrest the dies 20 into the slips 18, and the slips 18 into the inclined recesses 90, and thereby enhances frictional engagement of the dies to the casing section 10 during make up and break out operations.

Although present seat 16 is preferably shown as having a conical form, it would be well understood by a person of skill in the art that numerous alternative forms of seats 16 are possible that would cause the slips 18 to bias radially inwardly as they move axially down the seat 16. For example, the seat 16 may alternatively have a cylindrical form comprised of one or more inclined elements 30.

Preferably, the inclined recesses 90 are uniformly spaced around the seat 16. Most preferably, the inclined recesses 90 are arranged in diametrically opposing pairs.

The dies 20 of the present invention are illustrated in a preferred embodiment in Figures 2 and 3. Most preferably each slip 18 comprises three dies 20 arranged axially along the slip 18. Support means are provided to support the dies 20 on the slips 18. A most preferred embodiment of dies 20 and slips 18 is depicted in Figures 3 and 4, in which independent axial load transfer keys or tongues 34 are formed on a front face 36 of the slip 18 that are received in corresponding load transfer grooves 38 formed on a

rear face 40 of the dies 20. A front face 42 of the dies 20 can have any number of profiles and gripping surfaces well known in the art to engage and grip a range of casing joint diameters. The profile may be concave or may be any suitable profile to capture a tubular member when the die 20 comes in contact with such member. Examples of such profiles are well known in the art and would be understood by a skilled practitioner to be included in the scope of the present invention. If concave, the profile of the front face 42 of the dies 20 may preferably have a singular radius of curvature, or a compound radial profile comprising one or more profile sections each having the same or different radii of curvature with either the same or different centers. The surface of the front face 42 of the die 20 may be smooth or may be textured, scored, etched or ridged to provide further gripping of the casing joint 10.

In the foregoing specification, the invention has been described with a specific embodiment thereof; however, it will be evident that various modifications and changes may be made thereto without departing from the broader spirit and scope of the invention.

Claims

1. A gripping system for gripping oil well casing, casing string or other string comprising one or more slips cammed against one or more inclined recesses when the gripping system is rotated to enhance gripping engagement of the casing.

2. The gripping system of claim 1, wherein the one or more inclined recesses capture at least a portion of the one or more slips.

3. The gripping system of claim 2, wherein at least an axial portion of said one or more inclined recesses surrounds greater than 180 degrees of the one or more slips.

4. The gripping system of claim 3, wherein the one or more slips have a smaller cross section than said one or more inclined recesses.

5. The gripping system of claim 4, wherein rotation of the gripping system serves to rotate a front face of the one or more slips and to cam a rear face of the one or more slips against the one or more inclined recesses.

6. The gripping system of claim 2, wherein one or more recesses have a cross sectional geometry selected from the group consisting of partial circles, partial rectangles, partial squares, partial ovals, partial rhomboids and partial triangles.

7. The gripping system of claim 6, wherein at least a portion of the one or more inclined recesses have a part cylindrical geometry and at least a portion of the one or more slips have a corresponding cylindrical geometry.

8. The gripping system of claim 1, wherein the one or more inclined recesses are housed in a seat.

9. The gripping system of claim 8, wherein the seat has geometry selected from conical and cylindrical.

10. The gripping systems of claim 9, wherein the one or more inclined recesses are uniformly spaced around the seat.

11. A gripping system for gripping oil well casing, casing string or other string comprising one or more slips received into one or more inclined recesses.

12. The gripping system of claim 11, wherein at least a portion of the one or more slips are captured by the one or more inclined recesses.

13. The gripping system of claim 12, wherein the one or more recesses comprise a cross sectional geometry for at least a portion of the axial length thereof that surrounds greater than 180 degrees of the one or more slips.

14. The gripping system of claim 11, wherein the one or more slips have a smaller cross section than said one or more inclined recesses.

15. The gripping system of claim 14, wherein rotation of the gripping system serves to rotate a front face of the one or more slips and to force a rear face of the one or more slips against the one or more inclined recesses.

16. The gripping system of claim 11, wherein one or more recesses have a cross sectional geometry selected from the group consisting of partial circles, partial rectangles, partial squares, partial ovals, partial rhomboids and partial triangles.

17. The gripping system of claim 16, wherein at least a portion of the one or more

inclined recesses have a part cylindrical geometry and at least a portion of the one or more slips have a corresponding cylindrical geometry.

18. The gripping system of claim 17, wherein at least a portion of the axial length of the inclined recess has a cross sectional geometry that is more than a semi-circle.

19. The gripping system of claim 11, wherein the one or more inclined recesses are housed in a seat.

20. The gripping system of claim 19, wherein the seat has geometry selected from conical and cylindrical.

21. The gripping systems of claim 20, wherein the one or more inclined recesses are uniformly spaced around the seat.

22. A method of gripping casing sections or casing strings, said method comprising the steps of:

a) providing a gripping system comprising one or more recesses and one or more slips;

b) setting said one or more slips on the casing section; and

c) rotating the gripping system to cam said one or more slips against said one or more inclined recesses,

wherein camming said one or more slips against said one or more inclined recesses serves to enhance gripping engagement on the casing.

23. The method of claim 22, wherein the one or more slips are at least partially captured by the one or more inclined recesses.

24. The method of claim 23, wherein the one or more recesses comprise a cross

sectional geometry on at least a portion of the axial length thereof that surrounds greater than 180 degrees of the one or more slips.

25. The method of claim 24, wherein the one or more slips are cylindrical and wherein at least a portion of the axial length of the one or more inclined recesses has a cross sectional geometry that is more than a semi-circle.

26. The method of claim 25, wherein the one or more slips have a smaller cross section than said one or more inclined recesses.

27. The method of claim 26, wherein rotation of the gripping system serves to rotate the one or more slips and to cam a rear face of the one or more slips against the one or more inclined recesses.

28. A method of gripping casing sections or casing strings, said method comprising the steps of:

a) receiving a slip into each of one or more inclined recesses of a gripping system;
b) setting said one or more slips on the casing section; and
c) rotating the gripping system.

29. The method of claim 28, wherein the one or more slips are at least partially captured by the one or more inclined recesses.

30. The method of claim 29, wherein the one or more recesses comprise a cross sectional geometry on at least a portion of the axial length thereof that surrounds greater than 180 degrees of an axial surface of the one or more slips.

31. The method of claim 30, wherein the one or more slips are cylindrical and wherein at least a portion of the axial length of the one or more inclined recesses has a cross

sectional geometry that is more than a semi-circle.

32. The method of claim 31, wherein the one or more slips have a smaller cross section than said one or more inclined recesses.

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33. The method of claim 32, wherein rotation of the gripping system serves to rotate the one or more slips and to cam a rear face of the one or more slips against the one or more inclined recesses.

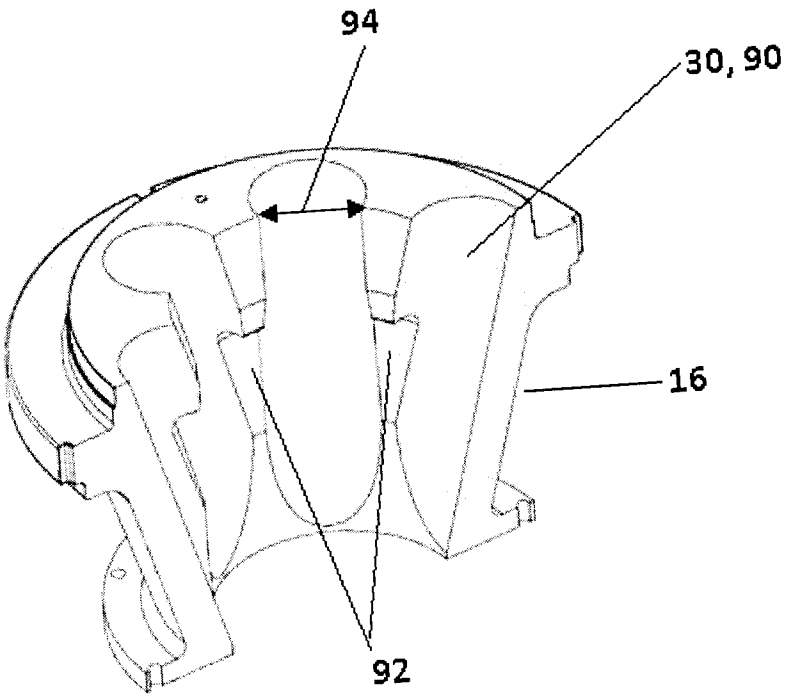

Figure 1

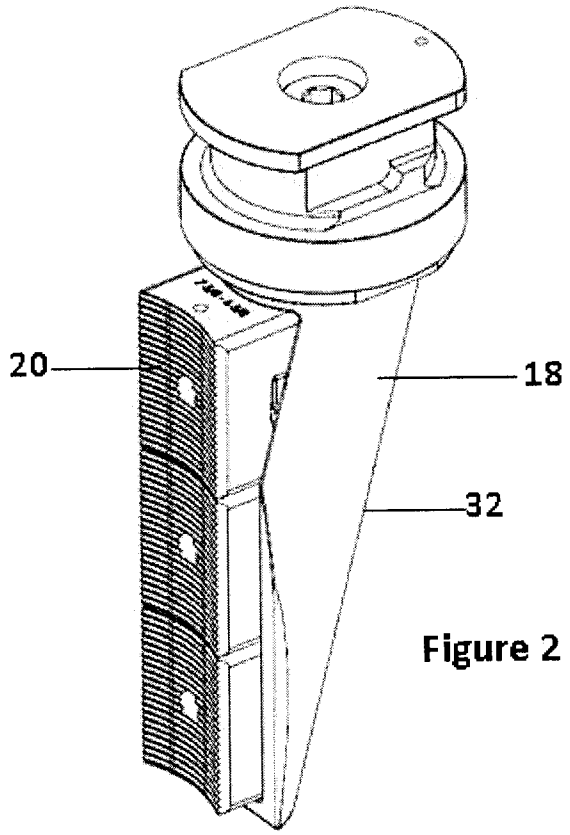

Figure 2

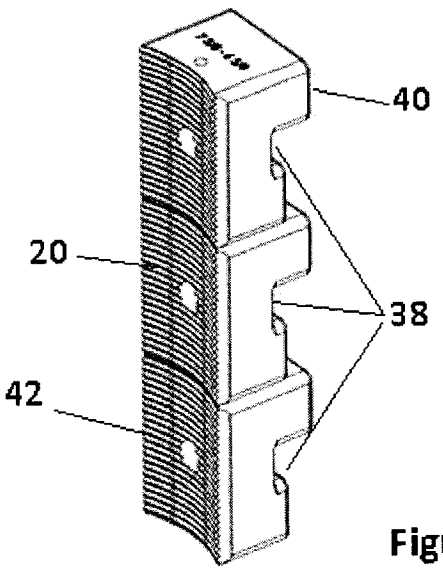

Figure 3

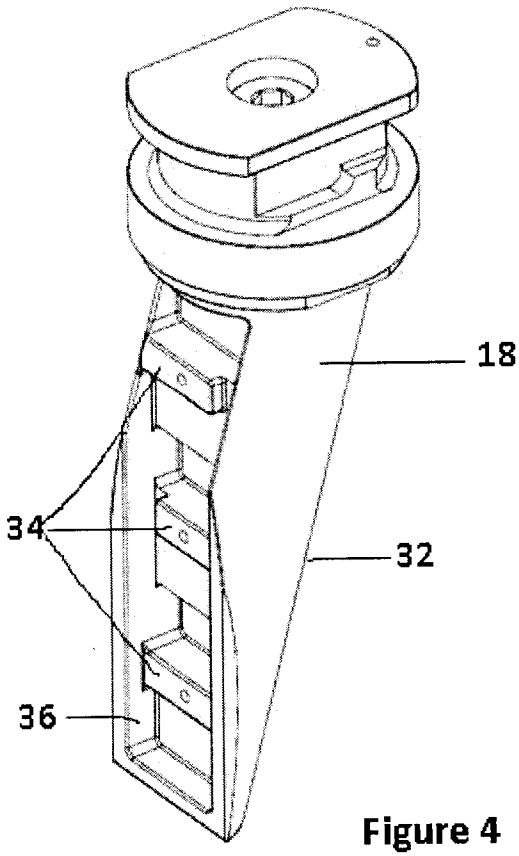

Figure 4

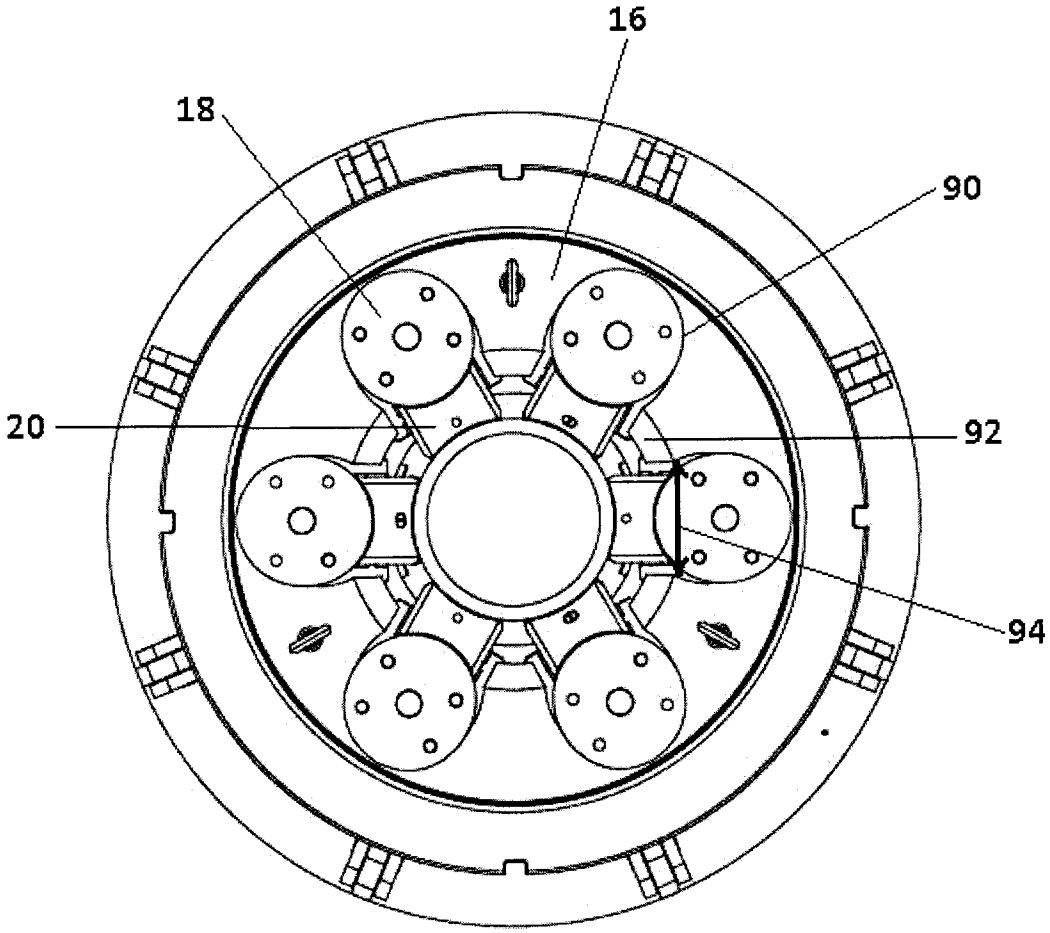

Figure 5

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CA2013/000411

A. CLASSIFICATION OF SUBJECT MATTER
IPC: ***E21B 19/10*** (2006.01) , ***E21B 19/07*** (2006.01)
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)
IPC: ***E21B 19/10*** (2006.01) , ***E21B 19/07*** (2006.01)

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

Electronic database(s) consulted during the international search (name of database(s) and, where practicable, search terms used)
Epoque (EPODOC); Keywords (slip+, wedge, cam+)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US1280850A, (Robichaux et al.) 08 October 1918 (08-10-1918) *whole document*	1-10 and 22-27
X	WO2011119214A2, (McIntosh et al.) 29 September 2011 (29-09-2011) *whole document*	11-14, 16-21 and 28-32
A	US4576254A, (Cox) 18 March 1986 (18-03-1986) *Fig. 3*	1-10 and 22-27
A	US3748702A, (Brown) 31 July 1973 (31-07-1973) *whole doc*	1-10 and 22-27
A	US3915244A, (Brown) 28 October 1975 (28-10-1975) *Fig. 7*	1-10 and 22-27
A	US2012337A, (Burns) 27 August 1935 (27-08-1935) *whole doc*	1-10 and 22-27

[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

* Special categories of cited documents :

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"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
06 August 2013 (06-08-2013)	12 August 2013 (12-08-2013)

Name and mailing address of the ISA/CA	Authorized officer
Canadian Intellectual Property Office Place du Portage I, C114 - 1st Floor, Box PCT 50 Victoria Street Gatineau, Quebec K1A 0C9 Facsimile No.: 001-819-953-2476	Jarret Diggins (819) 953-1611

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US1560701A, (Roy)10 November 1925 (10-11-1925) *whole doc*	11-21 and 28-32
A	CN102518403A, (Dezhong et al.) 27 June 2012 (27-06-2012) *whole doc*	11-21 and 28-32
A	US7775270B1, (Sipos) 17 August 2010 (17-08-2010) *whole doc*	11-21 and 28-32
A	US2003066717A1, (Buck) 10 April 2003 (10-04-2003) *Figs. 6 and 10*	11-21 and 28-32

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CA2013/000411

Patent Document Cited in Search Report	Publication Date	Patent Family Member(s)	Publication Date
US1280850A	08 October 1918 (08-10-1918)	None	
WO2011119214A2	29 September 2011 (29-09-2011)	US2013008641A1	10 January 2013 (10-01-2013)
US4576254A	18 March 1986 (18-03-1986)	None	
US3748702A	31 July 1973 (31-07-1973)	None	
US3915244A	28 October 1975 (28-10-1975)	None	
US2012337A	27 August 1935 (27-08-1935)	None	
US1560701A	10 November 1925 (10-11-1925)	None	
CN102518403A	27 June 2012 (27-06-2012)	None	
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		US6640939B2	04 November 2003 (04-11-2003)
		WO03031243A2	17 April 2003 (17-04-2003)
		WO03031243A8	04 September 2003 (04-09-2003)
		WO03031243A3	06 November 2003 (06-11-2003