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(54) Title: CASING RUNNING TOOL

(57) Abstract: A device is taught for gripping casing joints comprising one or more first cylinders and one or more second cylinders actuated by a singular hydraulic system. A second device is taught comprising a gripping system, said gripping system 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 third device is taught comprising a gripping system, said gripping system comprising one or more slips received into one or more inclined recesses. A fourth device is taught comprising one or more dies supported on one or more said slips by means of mating load transfer profiles. A fifth device is taught comprising a tubular guide means. A sixth device is taught comprising an integral fluid compensator chamber. A seventh device is taught comprising a hydraulic swivel comprising one or more sealing means having predictable seal fluid leak rates.

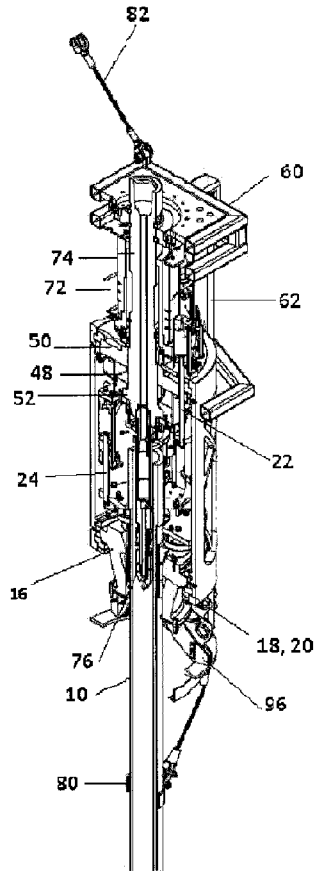

Figure 2a

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Casing Running Tool

Field of the Invention

The present invention relates to a device and a system for lifting, lowering and rotating casing joints to make up and break out casing strings.

Background

In down-hole drilling and extraction processes, casing, also called tubulars or piping, is run down the wellbore for the purposes of drilling, performing operations or producing oil from the well. Casing is made up by connecting multiple threaded casing sections together and feeding them into the wellbore. Typically, casing sections have a tapered female thread at one end and a tapered male thread at the other end. The male end of a second casing section is threaded into the female end of a first casing section to makeup the casing string. Certain casings are equipped with what are often referred to as premium grade connections. Rotation of the first casing into the second casing is conducted until the tapered ends engage one another at the shoulder point. A metal-to-metal seal is thus formed by engagement of the two threaded casing sections.

A typical procedure for making up casing strings involves first connecting a single joint elevator assembly, casing running tool (CRT) and other related devices to a top drive system. The entire assembly is then lowered to the rig floor and the single joint elevator assembly picks up a new joint of casing to be made up. The assembly is raised to raise the casing joint into position below the CRT and above a casing string to be made up, the casing string being gripped in place by a flush mount spider or similar device. The entire assembly is then lowered so that the male thread of the casing joint is engaged with the female thread of the uppermost casing of the casing string and the CRT rotatably grips the casing joint, either internally or externally.

The top drive is rotated to make up the threads between the new casing joint and the uppermost casing of the casing string. The CRT's gripping mechanism grips the new casing joint and transfers the weight of the newly made up connection from the flush

mount spider, so that the spider can be released. The CRT assembly then lowers the newly made up connection to the rig floor where the spider grips an upper end of the newly made up casing section of the casing string. The single joint elevator assembly is then released and is prepared to pick up the next casing joint to be made up. The CRT gripping mechanism is released from the casing joint and the top drive, CRT and single joint elevator assembly, now carrying a new joint to be installed in the string, are lifted into position for the next make up.

A reverse procedure is practiced for breaking out casing joints from a casing string.

Casing running tools conduct a number of complex operations and are typically made up of numerous moving and working parts. The casing running tool must be able to carry large loads while rotationally gripping the casing joint to be made up. It also provides a hydraulic seal between the casing and the top drive to enable the circulation of fluids. It must be easily operated and controlled and rapidly maintainable during wellbore operations.

A constant need and interest therefore exists in the art to develop improved casing running tool devices and methods for making up casing strings.

Summary

A first device is taught for gripping casing joints for making up or breaking out casing strings comprising one or more hydraulic cylinders. The one or more hydraulic cylinders comprise one or more first cylinders to actuate gripping and releasing of casing joints and one or more second cylinders, retractable for maintenance and replacement of gripping elements of the device, wherein said one or more hydraulic cylinders are actuated by a singular hydraulic system.

A second device is taught for gripping casing joints for making up or breaking out casing strings. The device comprises a gripping system, said gripping system 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 third device is taught for gripping casing joints for making up or breaking out

casing strings. The device comprises a gripping system, said gripping system comprising one or more slips received into one or more inclined recesses.

A fourth device is taught for gripping casing joints for making up or breaking out casing strings. The device comprises one or more dies supported on one or more slips by means of mating axial load transfer profiles formed on said slips and on each of said dies.

A fifth device is taught for gripping casing joints for making up or breaking out casing strings, said device comprising a tubular guide extending from a lower end of the device to receive and center the casing joint into a central bore of the device.

A sixth device is taught for making up or breaking out casing strings comprising an integral fluid compensator chamber.

A seventh device for making up or breaking out casing strings comprising a hydraulic swivel to house fluids for hydraulic actuation of the device, wherein said hydraulic swivel comprises one or more sealing means having predictable and controllable seal fluid leak rates.

Brief Description of the Drawings

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

Figure 1a is a first isometric view of one example of the casing running tool and related devices of the present invention;

Figure 1b is a second isometric view of one example of the casing running tool and related devices of the present invention;

Figure 2a is a first cross-sectional elevation view of one example of the casing running tool of the present invention;

Figure 2b is a second cross-sectional elevation view of one example of the casing running tool of the present invention;

Figure 2c is a detailed cross-sectional elevation view of one example of a tubular guide of the casing running tool of the present invention;

Figure 3a is a cross-sectional elevation view of the present invention, showing short and long stroke cylinders in an extended position;

Figure 3b is a cross-sectional elevation view of the present invention, showing short stroke cylinders in a retracted position and long stroke cylinders in an extended position;

Figure 3c is a cross-sectional elevation view of the present invention, showing short and long stroke cylinders in a retracted position;

Figure 4 is a schematic diagram of one example of the hydraulic system for the gripping members of the present invention;

Figure 5a is an isometric view of a part of the gripping members of the present invention;

Figure 5b is an isometric view of further parts of gripping members of the present invention;

Figure 5c is an isometric view of further parts of gripping members of the present invention;

Figure 5d is an isometric view of yet further parts of gripping members of the present invention; and

Figure 5e is a top plan view of one embodiment of the present gripping members

Description of the Invention

The present invention relates to a device and system for making up casing strings. The present invention more specifically relates to a casing running tool (CRT) that connects directly or indirectly to a top drive on a drilling rig.

With reference to Figures 1a, 1b, 2a and 2b the present CRT 2 can preferably be used in association with a single joint elevator assembly 4 to pick up casing joints 10

from the rig floor. An upper end 6 of the CRT 2 may be connected or indirectly to the top drive (not shown). In one embodiment the CRT 2 may be connected to the top drive by means of a sub that rotates with the top drive and the CRT 2. A lower end 8 of the CRT 2 is configured to include a gripping system 14 to grip a casing section or joint 10, to thereby transfer top drive torque to makeup or breakout a casing connection at the rig floor level.

As seen in Figure 2 c, the lower end 8 preferably comprises a tubular guide 96 that acts to center and align the casing section 10 as it is fed into the gripping system 14. This ensures that the casing section is fed into a central bore of the gripping system 14, and prevents the casing section 10 from striking potential sensitive elements within the griping system 14.

The single joint elevator assembly 4 of the present invention comprises a single joint assembly frame 60 that is supported on the sub or on an upper end of the CRT 2 in a rotatable fashion such that the CRT 2 is allowed to rotate while the single joint assembly frame 60 remains stationary. In a further preferred embodiment, the single joint assembly frame 60 is attached to the CRT 2 by means of a ball bearing connection between the CRT 2 and one or more plates of the single joint assembly frame 60. Further preferably, the single joint assembly frame 60 may additionally be attached for non-rotation to a non-rotational part of the top drive by attachments 82 to relieve any dynamic friction that may build up between the CRT 2 and the single joint assembly frame 60 and to prevent rotation of the single joint assembly frame 60 due to such dynamic friction. Although the single joint assembly frame 60 is preferably shown as having the form of a rectilinear frame in the figures, it would be well understood by those skilled in the art that other structures are also possible and encompassed by the scope of the present invention.

One or more link tilt arms 62 are pivotably connected to the single joint assembly frame 60 at an upper end thereof. A lower end of the one or more link tilt arms 62 are connected to a single joint elevator 80 for grasping a casing joint 10 to be made up on a casing string. The link tilt arms 62 are actuated to move about pivot pin

66 by means of a pair of link arm cylinders 68 that swing the elevator assembly 4 out to grasp a casing joint 10 and swing the casing joint 10 back into position below the CRT 2 and above a casing string at the rig floor. It would be well understood by a person of skill in the art that a single link tilt arm 62 or more than one link tilt arm 62 can be possible and such embodiments are included within the scope or the present invention. Should more than more than one link tilt arms 62 be used, the multiple link tilt arms 62 are connected at their upper ends to one or more sides of the single joint assembly frame 60.

Alternative to using a single joint elevator assembly 4, it is also possible to use a pair of parallel arms that are pivotably suspended at a first end from a non-rotational portion of the top drive. The second end of the parallel arms can be fixed with a device that allows the parallel arms to pick up casing joints and lower the casing joints below the CRT 2 and over a casing string to be made up.

The CRT further comprises a swivel 72 that houses fluids for hydraulic actuation of the CRT 2. An outer shell 74 of the swivel 72 is prevented against rotation by being attached to the single joint assembly frame 60 and optionally also by being attached to non-rotational parts of the top drive. This allows the outer shell 74 of the swivel 72 to connect to hosing and tubing supplying hydraulic fluids to the swivel 72. The swivel 72 acts to transfer fluid pressure from the hydraulic hoses to the CRT 2. In a further preferred embodiment, the present swivel 72 incorporates the use of either seals with a predictable leak rate or controlled gap seals with a defined leak rate to provide lubrication to the seals of the swivel 72. These seals leak at a controlled rate, without failing.

The CRT's gripping system 14 allows the top drive to hold the weight of the newly added casing joint 10 as well as the weight of the casing string suspended below it and then reposition the casing string for subsequent casing sections to be made up. When the casing joint 10 is initially picked up, an extended stinger, also called a circulating and fill-up tool (CFT) 76 is positioned inside of the casing section 10 to seal off the inside diameter of the casing section 10 and allow circulation of fluids to occur

while controlling back flow of fluids from the wellbore. CFT's are commercially available and well known in the art and any number of varieties of such devices can be used with the present invention without departing from the scope thereof.

The CRT 2 can optionally provide push down weight in combination with simultaneous rotation and circulation, in the case of "drilling with casing" operations or to assist in lowering the casing string to a desired depth in a deviated wellbore.

The CRT 2 of the present invention is shown in more detail in cross sectional Figures 3a, 3b and 3c. The CRT 2 comprises a casing gripping system 14 preferably comprising a machined seat 16, one or more slips 18 slidingly received in said seat 16, and one or more dies 20 supported on the slips 18. Although the figures illustrate three dies 20 per slip 18, it would be well known to a person skilled in the art that one or any number of dies 20 may be supported on each slip 18 and that there may be any number of slips 18 received in the seat 16, without departing from the scope of the present invention.

One or more cylinders preferably actuate setting and releasing of the casing gripping system on the casing sections 10. One or more first cylinders 24 extend to set one or more casing gripping members and retract to release said casing gripping members during casing make up or break out. One or more second cylinders 22 are maintained in an extended position during casing make up or break out and are retracted for maintenance or replacement of said gripping members.

Preferably, the one or more first cylinders 24 are long stroke cylinders and the one or more second cylinders 22 are short stroke cylinders. Further preferably, the one or more first cylinders 24 and one or more second cylinders 22 are mounted in series. More preferably, the second short stroke cylinders 22 are located axially above the first long stroke cylinders 24. First long stroke cylinders 24 extend to set casing gripping members and retract to release casing gripping members during casing make up or break out, thereby providing fast set and release response without the need for mechanical stops or detents. The second short stroke cylinders 22 are maintained in an extended position during casing make up or break out operations and can be retracted

to allow access to the slips 18 and dies 20 for maintenance or replacement. Figure 3a illustrates the lower long stroke cylinders 24 in an extended position to set the casing gripping members. Figure 3b shows the lower long stroke cylinders 24 in a retracted position to release casing gripping members and Figure 3c illustrates both the short stroke cylinder 22 and the long stroke cylinder 24 in a retracted position, to allow access to the casing gripping members for maintenance and repair. More preferably, each of the one or more first cylinders is arranged in a pair with each of the one or more second cylinders. Most preferably three pairs comprising a first cylinder and a second cylinder in series are used.

The one or more first and second cylinders are most preferably actuated by a singular hydraulic system, represented in the schematic diagram of Figure 4, which allows control of both first and second cylinders using only a single pair of hydraulic lines. Referencing Figure 4, the circuitry of the short stroke cylinders 22 is tied into the circuitry of the long stroke cylinders 24 by means of one or more operation valves 26 that supply fluid to keep the short stroke cylinders 22 in an extended position. The one or more operation valves 26 are preferably in the form of pilot operated control valves (POCV) 26. When required, one or more maintenance valves 28 are opened to supply fluid to the short stroke cylinders 22 to thereby close them. The one or more maintenance valves may be either a manual valve or a control valve.

The seat 16 of the casing gripping system 14 of the present casing running tool 2 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 5a and 5b, 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 slide into 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.

Radial inward movement of the slips 18 and dies 20 to grip the casing can be seen in Figures 3a and 3b; as the slips 18 move axially downwardly in the inclined recesses 30 of the seat 16. Most preferably, the inclined elements 30 are uniformly spaced around 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 5b and 5c. 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 5c and 5d, 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.

During casing make up operations and also in the cases of 'drilling with casing' and horizontal wellbore operations, significant downwards forces are required to counteract any upwards pressure experience by the casing string from wellbore fluids or from friction as the casing string is drilled into the wellbore. The operator may use a variety of methods, including circulation of drilling fluids in combination with rotation and/or reciprocation to reduce the friction and counteract these forces. The operator may also augment the weight of the casing string with a portion of the top drive weight to push down through the CRT 2. The present CRT 2 is preferably rated for circulation and fill-up pressures to approximately 5000 psi (34,474 kPa) and rotation at speeds of 100 rpm. Up to 30,000 lbs of compressive force (133 kN) or top drive weight can also be transferred through the present CRT 2 into the casings being run into the wellbore.

The top drive rotates to makeup the threads between the new casing joint 10 and last casing joint of the casing string. In some cases as many as 10 turns are needed to fully makeup the connection. For a common thread density of 8 threads per inch (3.15 threads per cm), 10 turns will consume 1 ¼" (3.2 cm) of thread, also known as thread loss. Thus, make up operations tend to shorten the distance between the casing string that is held in place typically by a flush mount spider or similar device, and the casing joint 10 that is gripped by and the CRT 2.

To avoid very high tensile loads on the string from thread loss, it is possible for the operator to attempt to compensate for thread loss by lowering the top drive. However, it is extremely difficult to lower the top drive in such small increments without risking too much top drive weight being set down and damaging the partially made-up threads.

The present CRT 2 preferably incorporates a fluid compensator in the form of a chamber 48 integral to the CRT 2, comprising one or more movable walls and one or more fixed walls. The fluid compensator provides a controlled spring-like action that allows a portion of the present CRT 2 to travel downward at a distance proportional to the thread loss to prevent high axial tension forces during casing make up. The fluid chamber 48 eliminates the need to move the top drive to compensate for thread loss.

More preferably, the fluid compensator is a hydraulic or pneumatic compensator in the form of an integral chamber 48 formed in the CRT 2, and most preferably it is a pneumatic chamber 48. More preferably, the pneumatic chamber 48 is defined by an upper fixed plate 50 and a lower movable piston 52. Most preferably the lower movable piston 52 is a lower end of a central CRT mandrel. If necessary to breakout a connection, the fluid compensator 48 offsets the weight of the joint being broken out plus the weight of the lower end of the CRT 2. The integral pneumatic compensator 48 opens during breakout to avoid developing the high axial compression forces that would occur if all components were fixed vertically.

In a typical make up operation, the present CRT 2, together with a CFT, an elevator assembly 4 and other optional devices are raised to the rig floor where they are attached to a threaded lower end of the top drive. The top drive is then lowered to a

position near the rig floor while the link tilt arm 62 is pivoted outward in preparation for picking up a new section of casing that has been raised from a pipe rack adjacent to the rig. The casing section 10 is presented on the rig floor at a location and angle that allows the single joint elevator 80 to grip the new casing section.

The top drive is raised to thereby pull the casing joint 10 up and along the rig's v-door ramp until it swings into a vertical position directly below the CRT 2, the motion being regulated by a pressure relief valve. The top drive then is raised until the new casing joint 10 is positioned above the existing casing string, set in a flush mount spider or similar device at the rig floor.

The top drive is lowered to allow the male thread of the casing joint 10 to engage the female thread of the uppermost casing of the casing string. The top drive continues to be lowered to engage the CFT with an upper end of the new casing joint 10. The CRT 2 gripping system 14 engages an outer diameter of the new casing joint 10. Once engaged by the CFT and CRT 2 and positioned over the existing casing string, the gripping system 14 of the CRT 2 is set on the new casing joint 10.

The top drive is slowly rotated to makeup the threads between the new casing joint 10 and the uppermost casing of the casing string, set in a flush mount spider or similar device. After one or two turns, the speed may be increased to a typical 10 to 20 rpm to spin-in the remaining threads. As the connection makes-up, the torque rises and the operator may slow down the rotation to 2 to 5 rpm for the final turns required to reach full makeup torque. The present CRT 2 preferably can transmit right-hand or left-hand torque of up to 35,000 ft lbs (47.5 kN m). As described above in a most preferred embodiment, configuration of the slips 18 and inclined recesses 90 of the present gripping system 14 serve to laterally retain and lock the slips 18 into the inclined recesses during torqueing. This serves to add mechanical strength to retain the gripping elements 14 in a set position during torqueing. This in turn alleviates at least some of the pressure on cylinders 24 as they extend to set the slips and lessens wear of the hydraulic swivel.

At this point, a rig pump can be engaged to fill the casing string with drilling fluid. Overflow is prevented by engagement of the CFT inside of the new casing joint 10.

Once made up, the top drive is raised. The CRT's gripping system 14 continues to grip the casing joint 10 and transfers the lifting force into the newly made up connection at the rig floor. As the top drive continues to be raised, the weight of the entire casing string, previously supported by a flush mount spider or similar device, is now transferred to the top drive and CRT 2. The weight can be very significant for deep wells requiring large diameter, thick walled casing goods. Additionally, in wells that are deviated, the frictional drag in the wellbore adds to this lifting load. The present CRT 2 is preferably rated to lift loads to about 315 tonnes or 700,000 lbs.

Once the flush mount spider or similar device has been relieved of the casing string load, it can be released and opened to lower the newly connected casing into the well bore until the uppermost casing of the casing string reaches the rig floor. The elevator assembly 4 can either be remotely or locally released, allowing the elevator assembly's tilt arm 68 to pivot outward and upward to prepare to pick-up a new joint of casing.

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 device for gripping casing joints for making up or breaking out casing strings comprising one or more hydraulic cylinders comprising:
   a) one or more first cylinders to actuate gripping and releasing of casing joints; and
   b) one or more second cylinders, retractable for maintenance and replacement of gripping elements of the device,

   wherein said one or more hydraulic cylinders are actuated by a singular hydraulic system.

2. The device of claim 1, wherein the singular hydraulic system comprises:
   a) one or more operation valves to control fluid flow to extend and retract the one or more first cylinders and to maintain the one or more second cylinders in an extended position during casing makeup and break out; and
   b) one or more maintenance valves, openable to supply fluid to retract the one or more second cylinders.

3. The device of claim 1, wherein the one or more first cylinders are long stroke cylinders and the one or more second cylinders are short stroke cylinders.

4. The device of claim 3, wherein the one or more first cylinders are arranged in series with the one or more second cylinders.

5. The device of claim 4, wherein the one or more first cylinders are located axially below the one or more second cylinders.

6. The device of claim 5, wherein each of the one or more first cylinders is arranged in a pair with each of the one or more second cylinders.

7. The device of claim 6, comprising three pairs of a first cylinder and a second

cylinder in series.

8. A device for gripping casing joints for making up or breaking out casing strings comprising a gripping system, said gripping system 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.

9. The device of claim 8, wherein the one or more inclined recesses capture at least a portion of the one or more slips.

10. The device of claim 9, wherein at least an axial portion of said one or more inclined recesses surrounds greater than 180 degrees of the one or more slips.

11. The device of claim 10, wherein the one or more slips have a smaller cross section than said one or more inclined recesses.

12. The device of claim 11, 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.

13. The device of claim 9, 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.

14. The device of claim 13, 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.

15. The device of claim 8, wherein the one or more inclined recesses are housed in a

seat.

16. The device of claim 15, wherein the seat has geometry selected from conical and cylindrical.

17. The devices of claim16, wherein the one or more inclined recesses are uniformly spaced around the seat.

18. A device for gripping casing joints for making up or breaking out casing strings comprising a gripping system, said gripping system comprising one or more slips received into one or more inclined recesses.

19. The device of claim 18, wherein at least a portion of the one or more slips are captured by the one or more inclined recesses.

20. The device of claim 19, 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.

21. The device of claim 18, wherein the one or more slips have a smaller cross section than said one or more inclined recesses.

22. The device of claim 21, 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.

23. The device of claim 18, 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.

24. The device of claim 23, 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.

25. The device of claim 24, 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.

26. The device of claim 18, wherein the one or more inclined recesses are housed in a seat.

27. The device of claim 26, wherein the seat has geometry selected from conical and cylindrical.

28. The devices of claim 27, wherein the one or more inclined recesses are uniformly spaced around the seat.

29. A device for gripping casing joints for making up or breaking out casing strings, said device comprising one or more dies supported on one or more slips by means of mating axial load transfer profiles formed on said slips and on each of said dies.

30. The device of claim 29, wherein the mating axial load transfer profile comprises a tongue and groove profile.

31. The device of claim 30, wherein the tongue and groove profile comprises one or more tongues formed on said slip and one or more grooves formed on each of said dies.

32. A device for gripping casing joints for making up or breaking out casing strings, said

device comprising a tubular guide extending from a lower end of the device to receive and center the casing joint into a central bore of the device.

33. A device for making up or breaking out casing strings comprising an integral fluid compensator chamber.

34. The device of claim 33, wherein the integral fluid compensator chamber is defined by one or more fixed walls and one or more movable walls.

35. The device of claim 34, wherein the integral fluid compensator chamber is expandable and contractible to compensate for axial movement during casing make up or casing break out.

36. The device of claim 35, wherein the integral fluid compensator chamber is a pneumatic compensator chamber.

37. The device of claim 36, wherein the integral fluid compensator chamber is a hydraulic compensator chamber.

38. A device for making up or breaking out casing strings comprising a hydraulic swivel to house fluids for hydraulic actuation of the device, wherein said hydraulic swivel comprises one or more sealing means having predictable and controllable seal fluid leak rates.

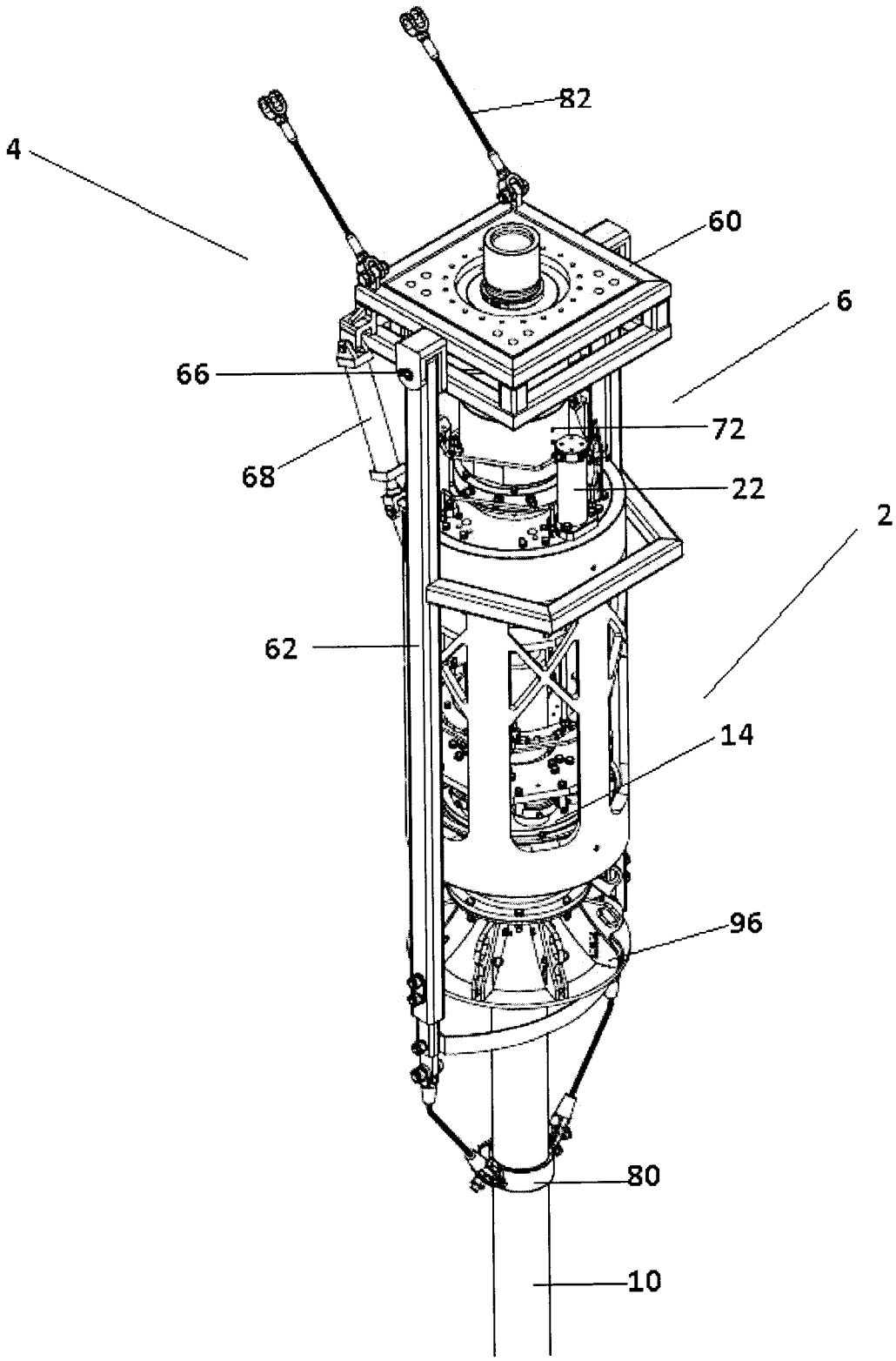

Figure 1a

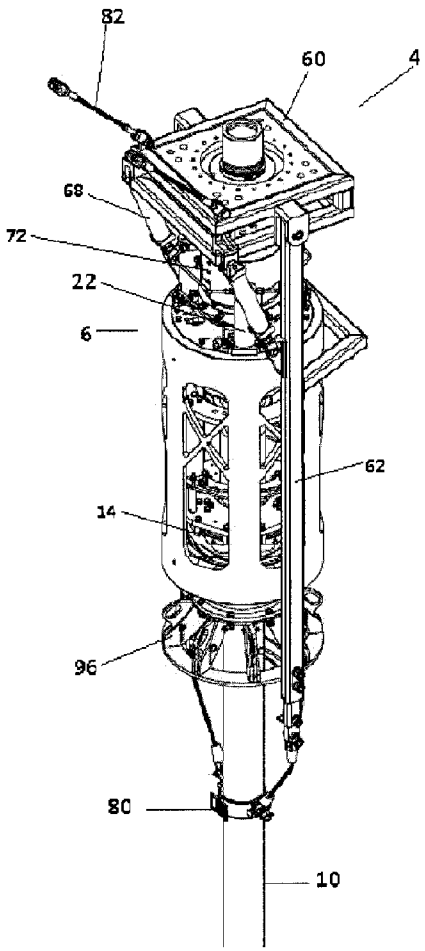

Figure 1b

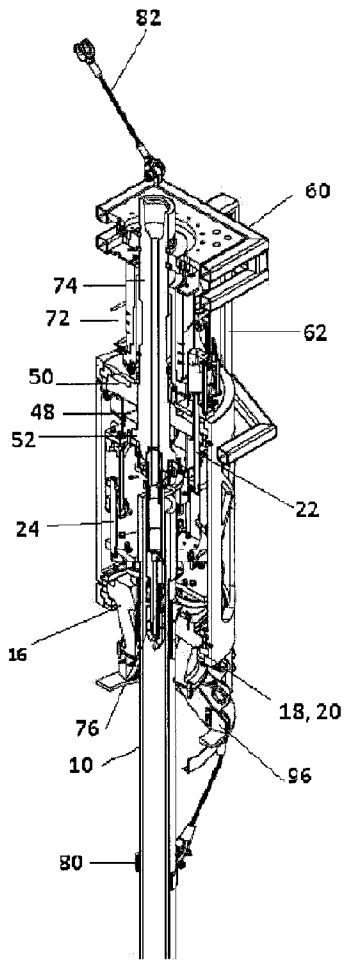

Figure 2a

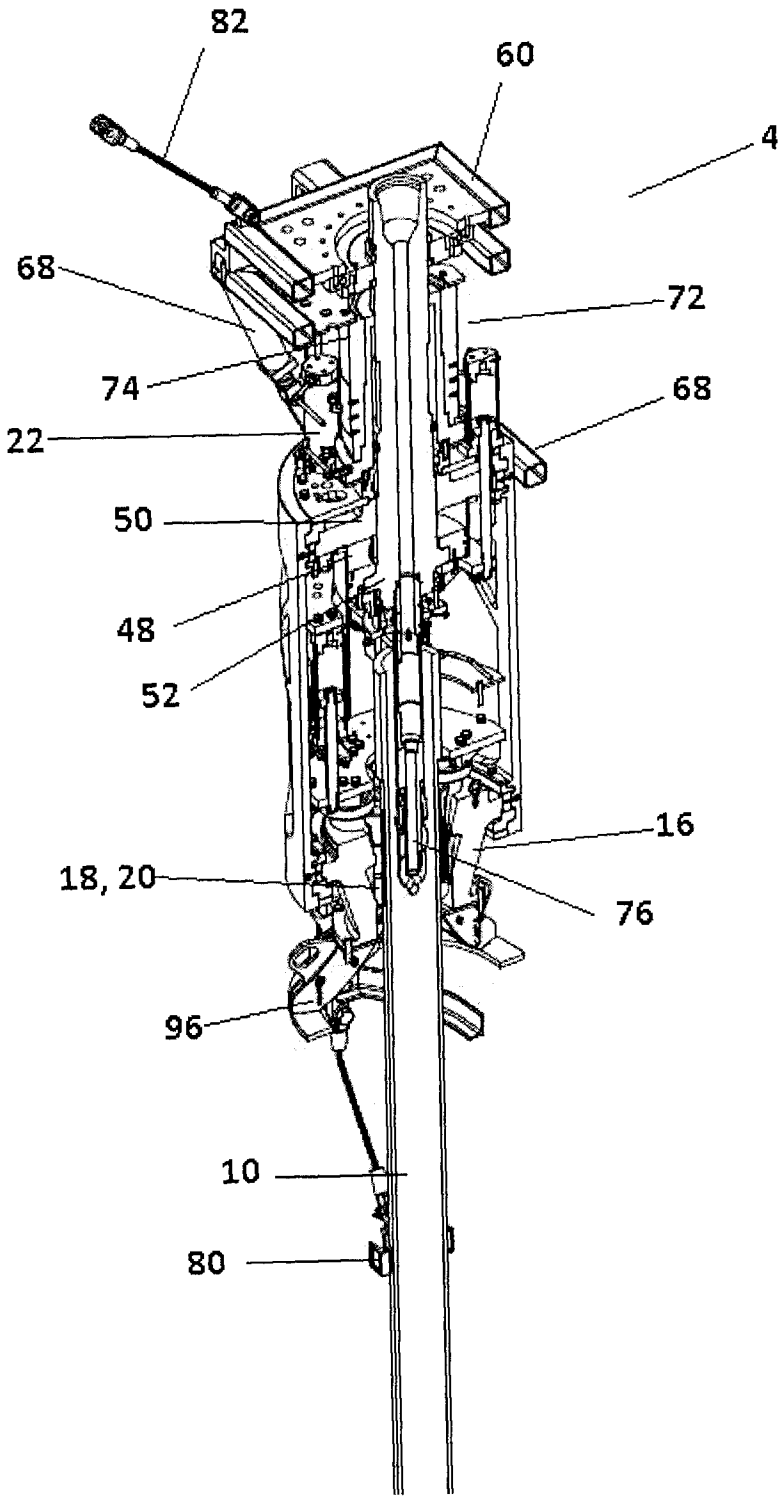

Figure 2b

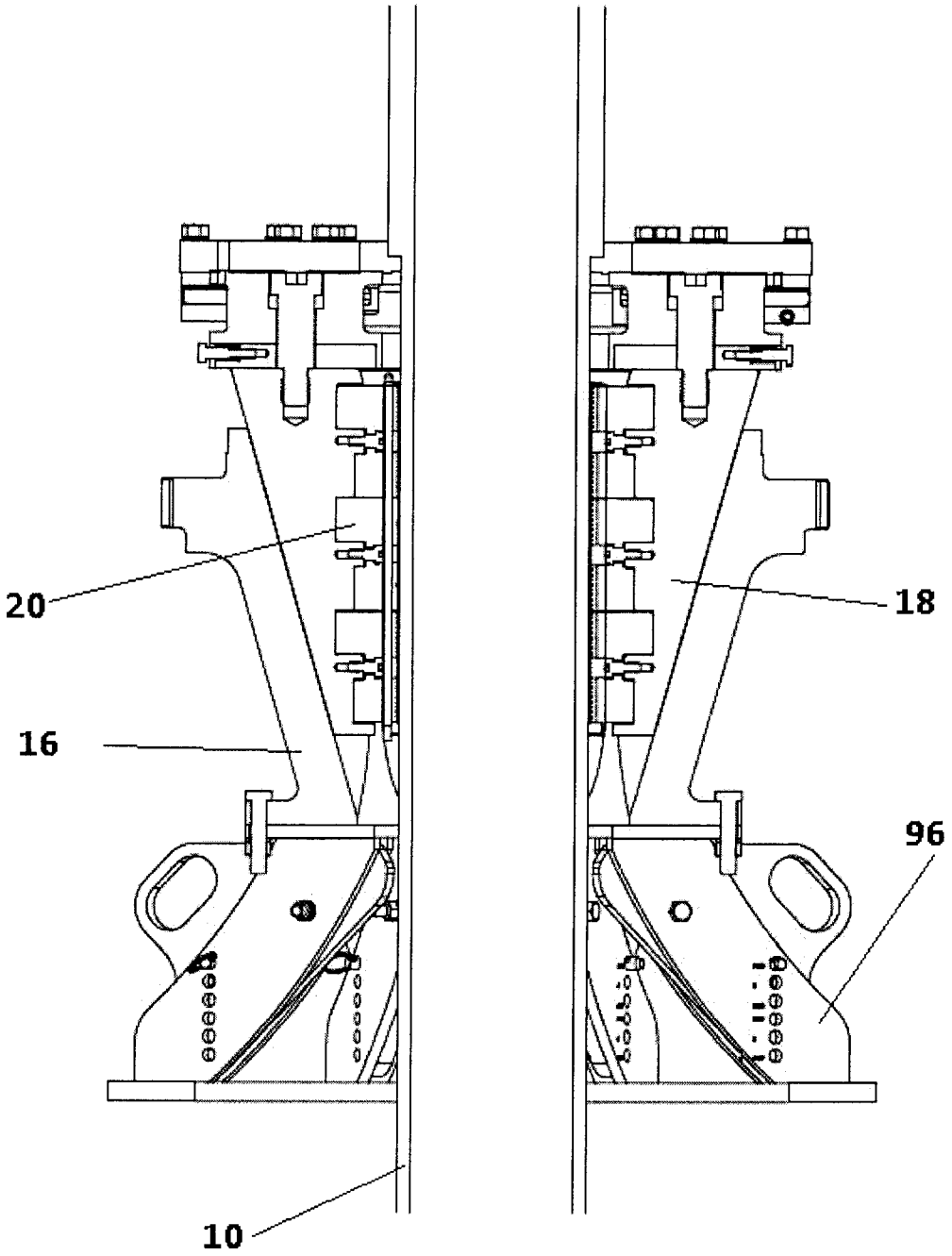

Figure 2c

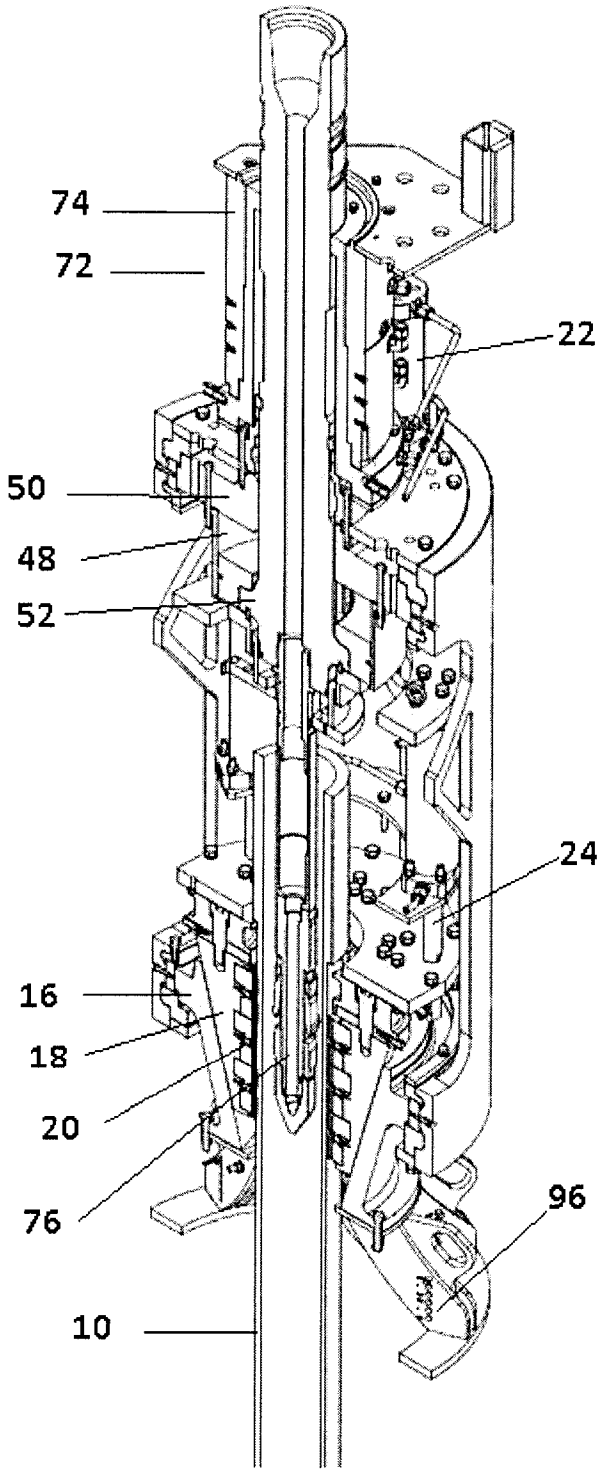

Figure 3a

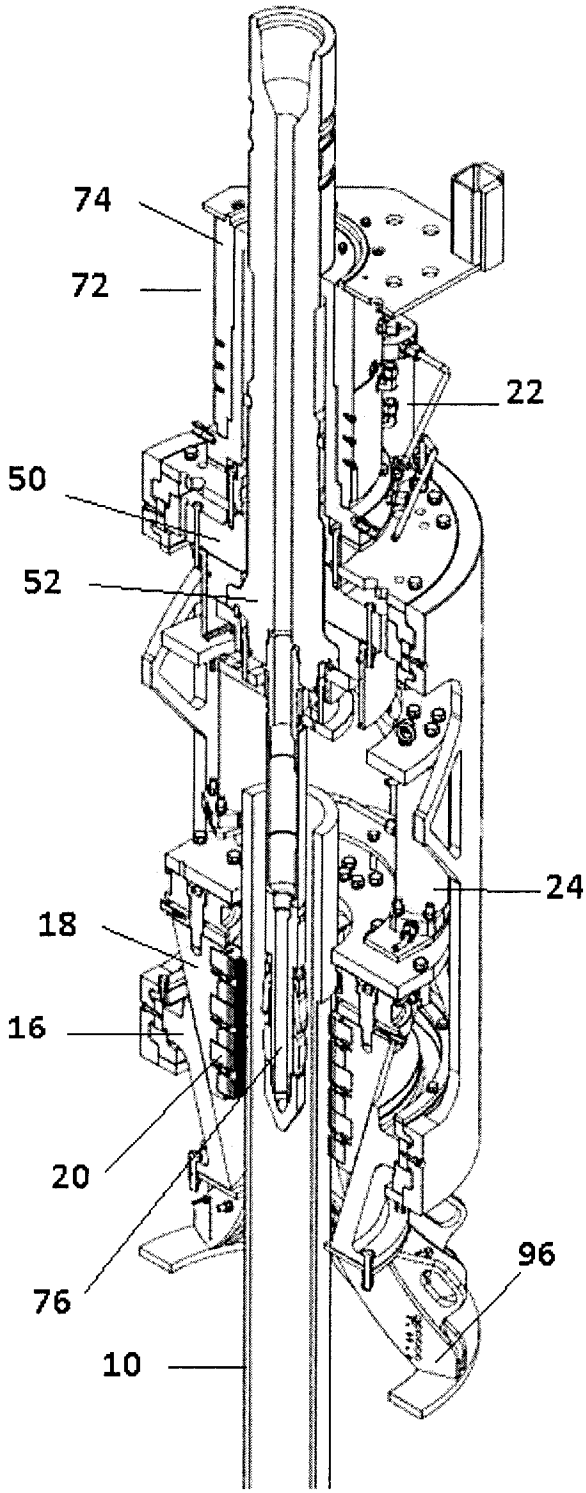

Figure 3b

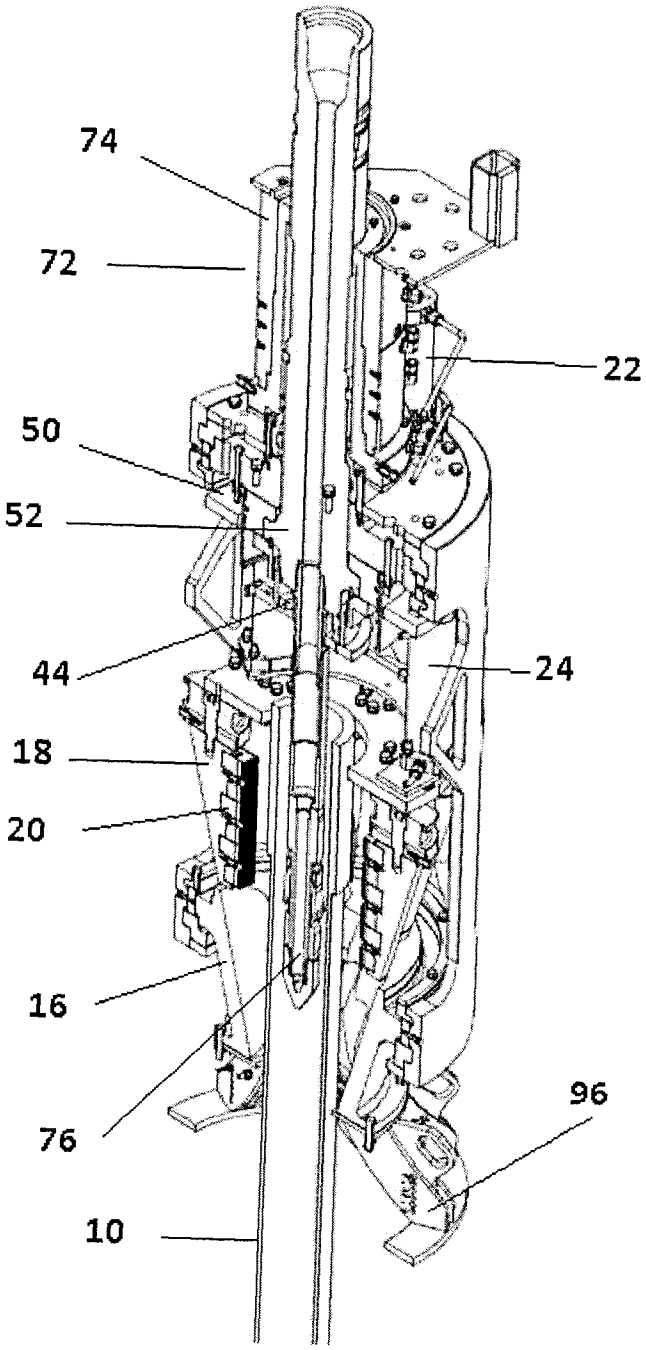

Figure 3c

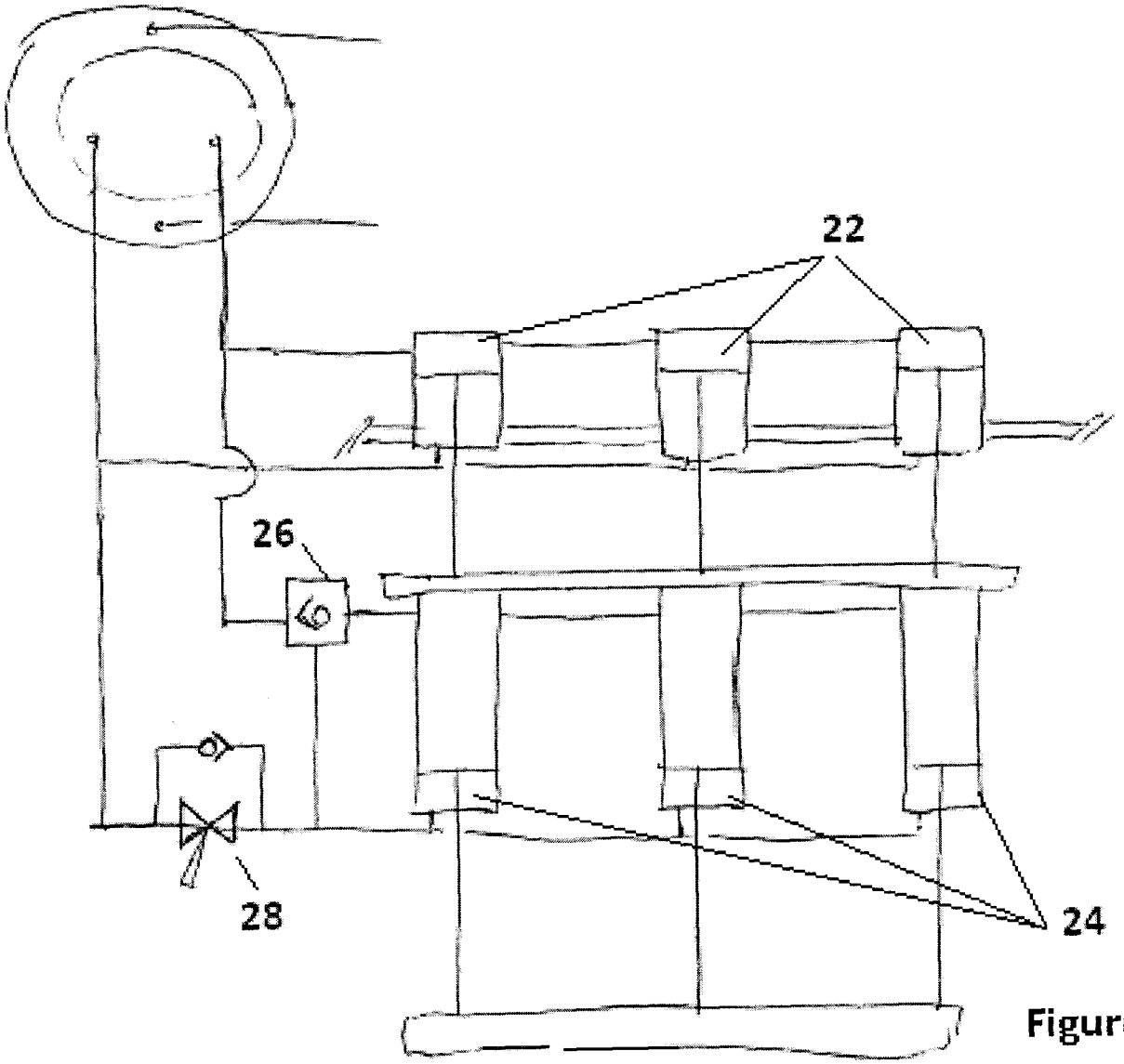

Figure 4

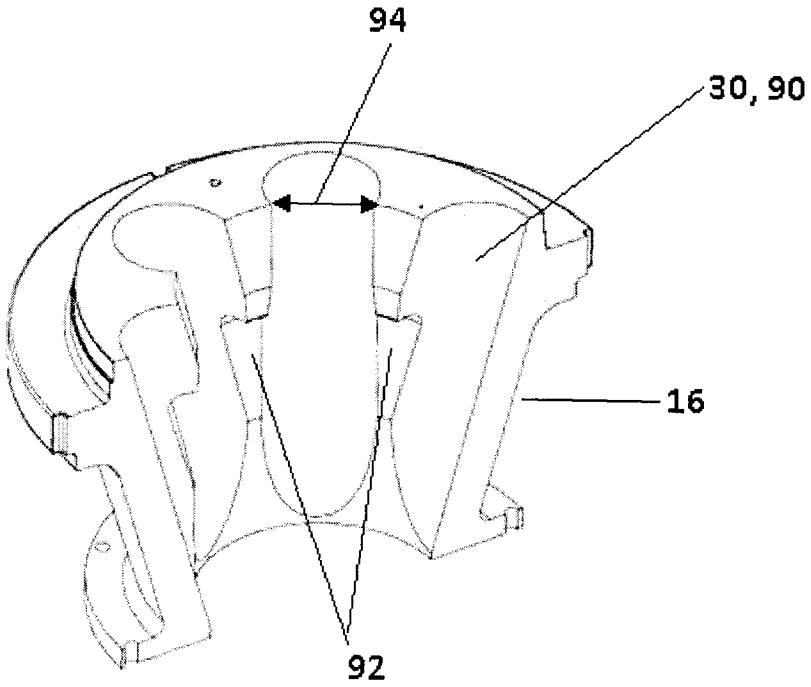

Figure 5a

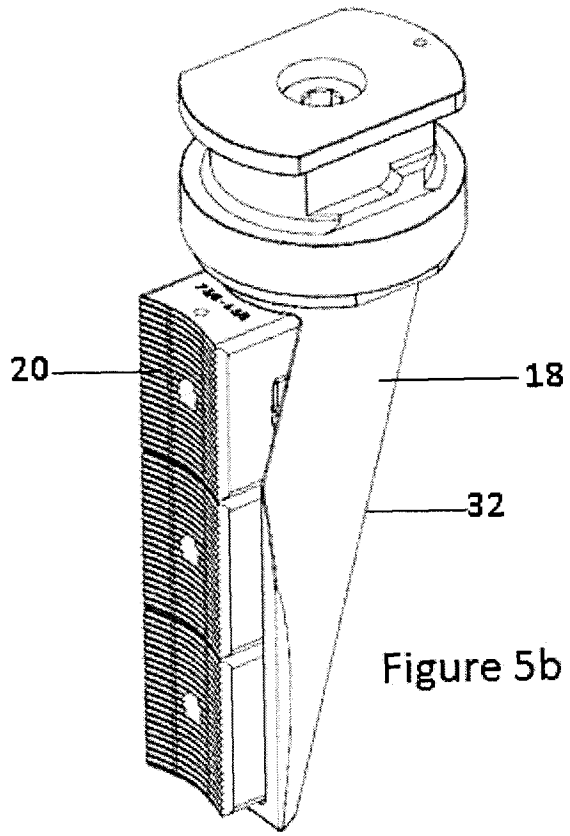

Figure 5b

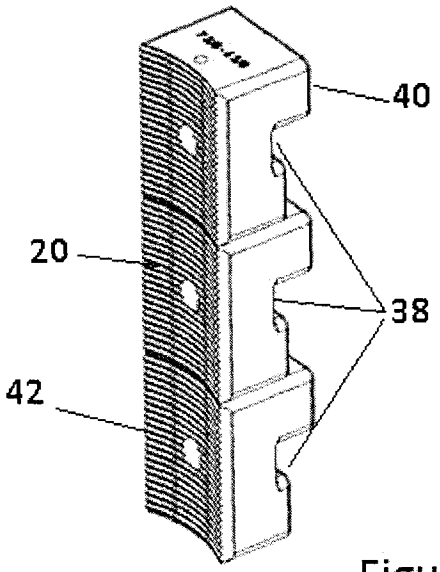

Figure 5c

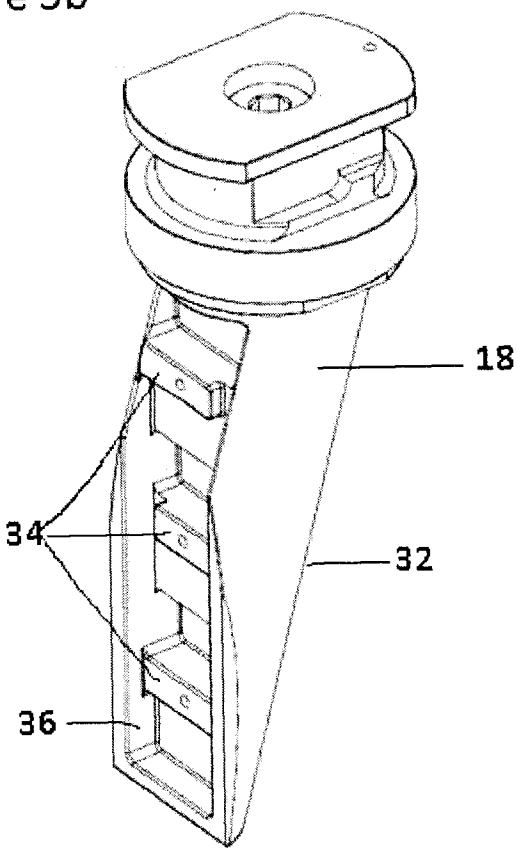

Figure 5d

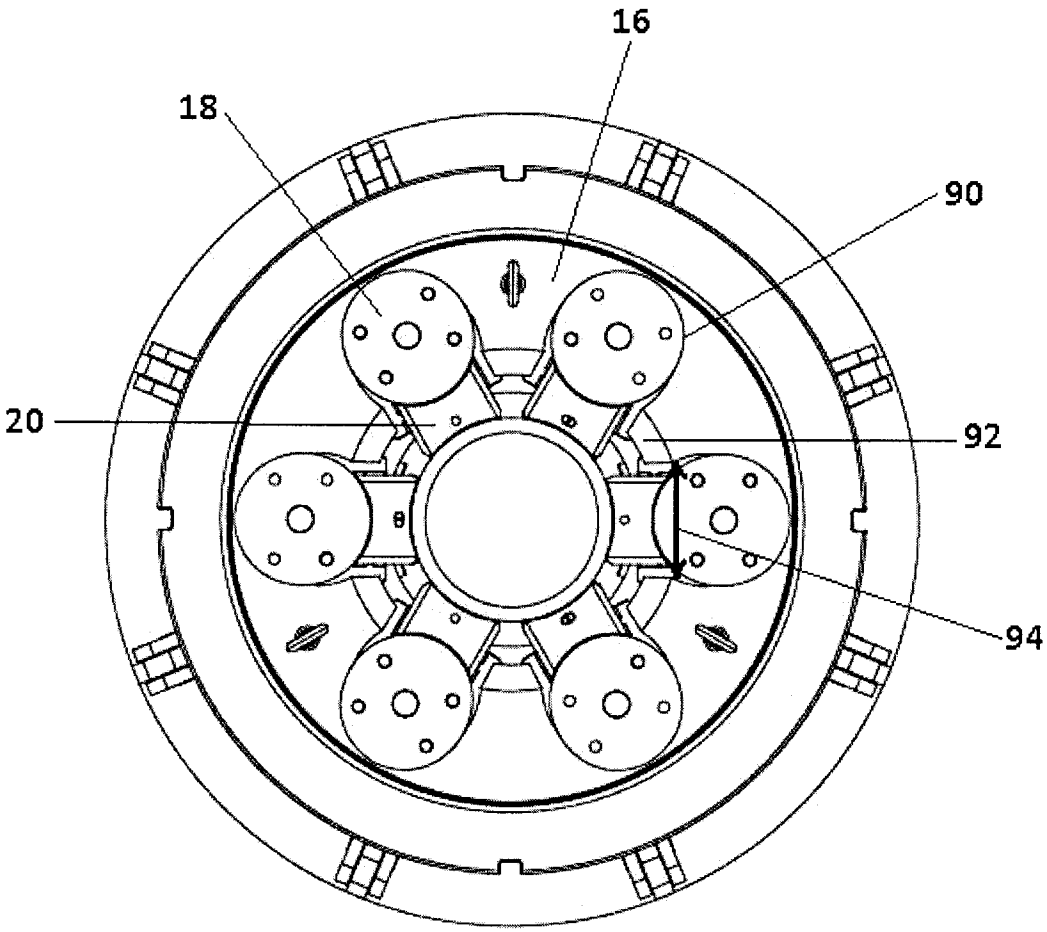

Figure 5e

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CA2013/000410

A. CLASSIFICATION OF SUBJECT MATTER
IPC: ***E21B 19/06*** (2006.01) , ***E21B 19/16*** (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 19/06*** (2006.01) , ***E21B 19/07*** (2006.01) , ***E21B 19/10*** (2006.01), ***E21B 19/16*** (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 (swivel, hydraulic, gap+, seal+, slip+, wedge, remov+, maint+, repair+, cam+, compens+)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US2006000600A1, (Pietras) 05 January 2006 (05-01-2006) *Fig. 7*	1-7
A	US1280850A, (Robichaux et al.) 08 October 1918 (08-10-1918) *whole document*	8-17
X	WO2011119214A2, (McIntosh et al.) 29 September 2011 (29-09-2011) *whole document*	18-28
X	WO2004007896A2, (Ramey et al.) 22 January 2004 (22-01-2004) *whole document*	29-31
X	US2009120649A1, (Cerovsek) 14 May 2009 (14-05-2009) *Figs. 14 & 15*	32

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

* Special categories of cited documents :
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"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
30 July 2013 (30.07.2013)	05 August 2013 (05-08-2013)

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

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CA2013/000410

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of the first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons :

1. [ ] Claim Nos. :
because they relate to subject matter not required to be searched by this Authority, namely :

2. [ ] Claim Nos. :
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically :

3. [ ] Claim Nos. :
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows :

Group A: claims 1-7: Directed towards first cylinders to actuate gripping and second cylinders retractable for maintenance .
Group B: (claims 8-28) Directed towards a one or more slips received into one or more inclined recesses; and
Group C: (claims 29-32) Directed towards dies supported on one or more slips by mating axial load transfer profiles; and
Group D: (claims 33-37) Directed towards an integral fluid compensator chamber; and
Group E: (claims 38) Directed towards a hydraulic swivel to house fluids for hydraulic actuation of the device, said hydraulic swivel comprises one or more sealing means having predictable and controllable seal fluid leak rates.

1. [X] As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. [ ] As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.

3. [ ] As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claim Nos. :

4. [ ] No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claim Nos. :

Remark on Protest

[ ] The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

[ ] The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

[ ] No protest accompanied the payment of additional search fees.

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US2010101805A1, (Angelle) 29 April 2010 (29-04-2010) *Figs. 3 and 4*	32
X	US2006124353A1, (Juhasz et al.) 15 June 2006 (15-06-2006) *Fig8; Par[0071]*	33-37
X	US2005067168A1, (Baird) 31 March 2005 (31-03-2005) *Figs. 1a and 1b*	33-37
X	US2011253361A1, (Matherne, Jr. et al.) 20 October 2011 (20-10-2011) *whole doc*	38
X	US2009274545A1, (Liess et al.) 05 November 2009 (05-11-2009) *Figs. 35a-36a*	38
A	US2003066718A1, (Buck) 10 April 2003 (10-04-2003) *Fig. 14*	38
A	US3748702A, (Brown) 31 July 1973 (31-07-1973) *whole doc*	8-17
A	US7267168B1, (Sipos) 11 September 2007 (11-09-2007) *whole doc*	18-31
A	US3915244A, (Brown) 28 October 1975 (28-10-1975) *Fig. 7*	8-17
A	US2012337A, (Burns) 27 August 1935 (27-08-1935) *whole doc*	8-17
A	US4576254A, (Cox) 18 March 1986 (18-03-1986) *Fig. 3*	8-17
A	US2003066717A1, (Buck) 10 April 2003 (10-04-2003) *Figs. 6 and 10*	8-28
A	US2962919A, (Grundmann et al.) 06 December 1960 (06-12-1960) *whole doc*	29-31
A	US2009151934A1, (Heidecke et al.) 18 June 2009 (18-06-2009) *Fig. 5a*	38

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WO2004007896A2	22 January 2004 (22-01-2004)	AT372948T	15 September 2007 (15-09-2007)
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