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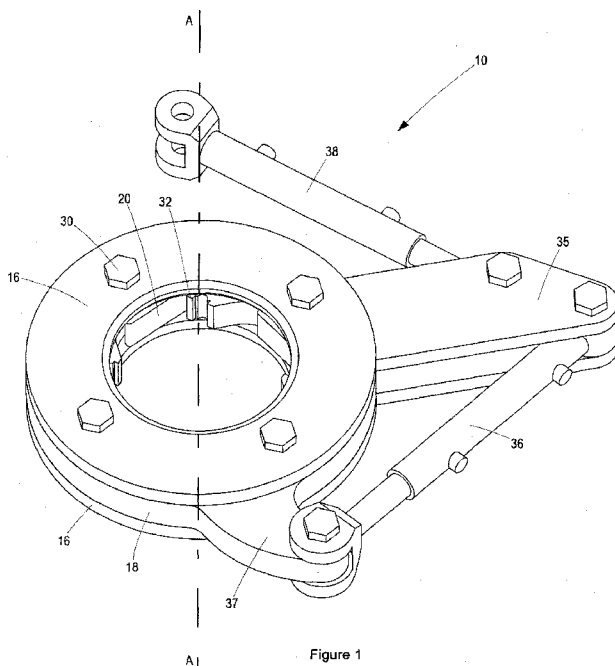
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(54) Title: APPARATUS FOR BREAKING THREADED PIPE CONNECTIONS



(57) Abstract: Apparatus (10) for breaking threaded pipe connections (12) includes a housing ring (16) that is, in use, rotatably connected to a frame (14), the housing ring (16) defining an aperture (10) for, in use, receiving a pipe section therethrough. At least three cams (20) are pivotally connected to the housing ring (16). A guide ring (18) is rotatable relative to the ring (16) between an open position in which the cams (20) are, in use, radially spaced from a pipe section extending therebetween and a clamped position in which the cams (20), in use, engage with and clamp the pipe section. The guide ring (18) defines at least three ramps (24), each ramp (24) causing a corresponding cam (20) to ride up the ramp (24), pivot and protrude radially inwards as the guide ring (18) is rotated from the open position to the clamped position; and includes at least three fingers (26) that bear against the cams (20) to cause the cams (20) to pivot and retract radially outwards as the guide (18) is rotated from the clamped position to the open position. Such that, at least a portion of each ramp (24) and corresponding finger (26) forms a recess defined by the guide ring (18) that receives at least a portion of the corresponding cam (20) therein when the guide ring (18) is in the open position.



## APPARATUS FOR BREAKING THREADED PIPE CONNECTIONS

### BACKGROUND

The present invention relates to apparatus for breaking threaded pipe connections. More specifically, the present invention relates to apparatus for clamping and rotating sections of a drill pipe string.

Chucks for breaking drill pipe strings are known. For instance, US4,092,881 "Apparatus for making-up and breaking threaded pipe connections" describes a frame supporting a turnable chuck and a non-turnable chuck, each chuck comprising a ring for receiving and clamping a pipe therein. A first pneumatic actuator causes the chucks to clamp on the pipe, while a second pneumatic actuator causes the turnable chuck to turn and break the threaded pipe connection.

US4,372,026 "Method and apparatus for connecting and disconnecting tubular members" at figures 11 and 12 describes chucks with: (i) rollers movable along a ramp; and (ii) sprags, to clamp a pipe section to be unthreaded. Similar arrangements are described in US8,186,246 "Gripping or clamping mechanism" and US5,676,226 "Sprag and roller one-way clutch assembly".

US4,631,987 "Power tongs" describes a chuck with gripping dies housed within a ring that are pivotal, but not displaceable relative to the ring between an open position in which the gripping die is housed within a cavity defined by the ring and a clamped position in which the gripping die extends from the cavity radially towards the axis of the ring. When in the clamped position, the cavity is "open", permitting ingress of dirt. Furthermore, when in the clamped position, the bias of a spring is required to return the gripping dies towards the open position.

A drawback of known systems is that they are susceptible to the ingress of dirt which, over time, increases wear and tear and impacts operation of the systems. A further drawback of many of the known systems is that they require complex mechanisms

including springs or gears to actuate the chuck jaws between the open and clamped positions.

The thread breaking apparatus according to the present invention aims to address these drawbacks.

### SUMMARY OF THE INVENTION

According a preferred embodiment of the present invention, apparatus for breaking threaded pipe connections includes:

a housing ring that is, in use, rotatably connected to a frame, the housing ring defining an aperture for, in use, receiving a pipe section therethrough;

at least three cams pivotally connected to the housing ring;

a guide ring rotatable relative to the housing ring between an open position in which the cams are, in use, radially spaced from a pipe section extending therebetween and a clamped position in which the cams, in use, engage with and clamp the pipe section, the guide ring:

defining at least three ramps, each ramp causing a corresponding cam to ride up the ramp, pivot and protrude radially inwards as the guide ring is rotated from the open position to the clamped position; and

including at least three fingers that bear against the cams to cause the cams to pivot and retract radially outwards as the guide ring is rotated from the clamped position to the open position,

wherein at least a portion of each ramp and corresponding finger forms a recess defined by the guide ring that receives at least a portion of the corresponding cam therein when the guide ring is in the open position.

Typically, the guide ring is sandwiched between a pair of housing rings.

Generally, the recess is enclosed between the housing rings to form a cavity.

Preferably, the ramps, fingers and cams are sized and shaped such that when the guide ring is in the open position, the fingers limit pivoting of the cams to less than 30 degrees. More preferably, the ramps, fingers and cams are sized and shaped such that when the guide ring is in the open position, the fingers limit pivoting of the cams to less than 20 degrees. Even more preferably, the ramps, fingers and cams are sized and shaped such that when the guide ring is in the open position, the fingers limit pivoting of the cams to less than 10 degrees. Optimally, the ramps, fingers and cams are sized and shaped such that when the guide ring is in the open position, the fingers limit pivoting of the cams to less than 5 degrees.

Typically, the threaded connection breaking apparatus further includes a means for causing the guide ring to rotate between the open and clamped positions.

Generally, the threaded connection breaking apparatus further includes a frame.

Preferably, the threaded connection breaking apparatus further includes means for causing the housing ring to rotate relative to the frame thereby, in use, to rotate a pipe section clamped by the cams.

Typically, operation of the housing ring rotating means is conditional upon the guide ring rotating means exerting and maintaining a predetermined force upon the guide ring.

Generally, each cam includes a cam tip distal the point at which the cam is pivotally connected to the housing ring, which cam tip is pivotally secured to the cam.

Preferably, one surface of the cam tip may be serrated.

Typically, the serrated surface is curved to form a concave with a radius between 50 mm and 100 mm.

Generally, one of the cam and the cam tip defines a circular bay and the other of the cam and the cam tip defines a circular protrusion sized and shaped to locate and rotate within the bay.

Preferably, the cam tip is pivotal relative to the cam by between 10 degrees and 30 degrees. More preferably, the cam tip is pivotal relative to the cam by between 15 degrees and 25 degrees.

Typically, the cam tip is substantially triangular defining an apex distal the point of connection with the cam having an angle between 5 degrees and 25 degrees.

Generally, the cam tip is made from a harder material than the material from which the cam is made.

Preferably, the guide ring defines a bore that extends linearly from the radial outer periphery of the guide ring to the ramp at a point outside the recess.

Typically, the radial outer periphery of the guide ring defines a notch adjacent the bore so as to provide a planar surface that is normal to the longitudinal axis of the bore.

Generally, a threaded portion is associated with the bore for co-operating with a threaded portion on a bolt sized to be received within the bore.

Preferably, the bolt is movable between: (i) a retracted position in which the bolt does not protrude radially inwards from the radial inner periphery of the guide ring; and (ii) an extended position in which the bolt protrudes radially inwards from the radial inner periphery of the guide ring and abuts a cam while the guide ring is in the clamped position, thereby locking the cam and guide ring in the clamped position.

Typically, the threaded connection breaking apparatus further includes a port associated with each cavity, the ports: (i) being defined by the housing ring and/or the guide ring; and (ii) facilitating the ejection of accumulated dirt from the cavity as the cam is received therein.

Generally, each cam is connected to the pair of housing rings by a pin spanning between the housing rings and extending through a bore defined by the cam.

Preferably, the ramps define a square aperture in the guide ring with recesses extending from corners of the square aperture.

### BRIEF DESCRIPTION OF THE DRAWINGS

The invention will now be described in more detail, by way of examples only, with reference to the accompanying drawings in which:

- Figure 1** is a perspective view of a threaded connection breaking apparatus according to a first embodiment of the present invention with the guide ring in the open position;
- Figure 2** is a side view of a threaded connection breaking apparatus according to Figure 1 mounted on a frame above a non-turnable chuck and a pipe extending therethrough;
- Figure 3** is a perspective view of the threaded connection breaking apparatus in Figure 1 with the guide ring in the clamped position;
- Figure 4** is a perspective exploded view of the threaded connection breaking apparatus in Figure 1;
- Figure 5** is a top view of the threaded connection breaking apparatus along plane X-X in Figure 2 with the guide ring in the open position;
- Figure 6** is a top view of the threaded connection breaking apparatus along plane X-X in Figure 2 with the guide ring in the clamped position; and
- Figure 7** is a cross sectional top view of a threaded connection breaking apparatus (along a similar plane as X-X in Figure 2) according to a second embodiment of the present invention with the guide ring in the clamped position.

### DESCRIPTIONS OF PREFERRED EMBODIMENTS

With reference to Figures 1 to 6 of the drawings, there is provided a first embodiment of apparatus 10 for breaking threaded pipe connections 12 in drill strings. The threaded

connection breaking apparatus 10 includes a frame 14, housing ring 16, guide ring 18 and cams 20.

When the drill rig (not shown) is set up, the apparatus 10 is secured above a non-turnable chuck 22 and the drill string 12 passed centrally through the apparatus 10 and non-turnable chuck.

The frame 14 is a steel structure to which the housing ring 16 is rotatably secured about axis A-A.

Figures 1 to 4 show a pair of housing rings defining a central, circular aperture (generally between 65 and 190mm in diameter) arranged concentric but spaced axially relative to each other.

A concentric guide ring 18 is rotatably sandwiched and captured between the housing rings 16. Turning to Figures 4 to 6, the guide ring 18 defines four ramps 24 that incline towards the longitudinal axis A-A as the ramps extend from a first end to a second end. At the first end of each ramp 24, the guide ring 18 includes a corresponding finger 26 that extends towards: (i) the longitudinal axis A-A; and (ii) the second end of the corresponding ramp 24, to form a recess 28 therebetween.

The ramps 24, fingers 26 and recesses 28 are arranged symmetrically around the guide ring 18. In plan view, the guide ring 18 defines a square central aperture with recesses 28 extending from corners of the square.

It will be appreciated that when the guide ring 18 is sandwiched between the housing rings 16, the recesses 28 are enclosed by the housing rings 16 to form cavities.

Four cams 20 are pivotally connected to the housing ring 16 via pins 30 that span between the housing rings 16 and extend through bores defined by the cams 20.

Each cam 20 is elongate in shape and includes a gripping formation 32 that, in use, facilitates gripping of a pipe 12 by the cam 20.

The guide ring 18 is rotatable relative to the housing rings 16 between an open position shown in Figures 1 and 5 and a clamped position shown in Figures 3 and 6. When in the open position, the cams 20 are retracted within the cavities 28 and, in use, spaced

radially from a pipe 12 extending axially through the housing rings 16, permitting the pipe 12 freely to rotate and move relative to the housing rings 16 along the longitudinal axis A-A.

As the guide ring 18 is rotated clockwise towards the clamped position, each cam 20 extends from its cavity 29 and travels along the corresponding ramp 24. As the cam 20 travels along the ramp 24, the cam 20 pivots about the pin 30 and protrudes radially inwards towards the longitudinal axis A-A until the gripping formation 32 on the cam 20 engages the pipe 12 to clamp the pipe 12 between the cams 18 and inhibit relative rotation between the pipe 12 and housing rings 16.

As the guide ring 18 is rotated anti-clockwise from the clamped position towards the open position, the fingers 26 bear against the cams 20 and cause the cams 20 to pivot radially outwards away from the longitudinal axis A-A. Simultaneously, the cams 20 are retracted into the cavities 28.

When in the open position, the cams 20 define a virtual central bore between 180mm and 200mm, preferably 190mm in diameter. When in the clamped position, the cams 20 define a virtual bore between 50mm and 70mm, preferably 60mm in diameter.

The cams 20, ramps 24 and fingers 26 are sized and shaped to ensure that when the guide ring 18 is in the open position, the fingers 24 limit pivoting of the cams 20 to: (i) less than 30 degrees; (ii) preferably less than 20 degrees; (iii) more preferably less than 10 degrees; and (iv) even more preferably less than 5 degrees.

In an alternative embodiment (not shown), The cams 20, ramps 24 and fingers 26 are sized and shaped to ensure that the openings to the cavities 28 are substantially closed by the cams 20 when the guide ring 18 is in the open position, the clamped position and any intermediate position. This inhibits ingress of dirt into the cavity 28. In this context, "substantially closed" means that the component parts do not define a gap permitting access to the cavity 28 wider than 15mm, preferably 10mm and more preferably 5mm.

Ports 34 are defined by the housing rings 16 and/or guide ring 18 to facilitate ejection of accumulated dirt in the cavities 28 as the cams 28 are retracted therein.



Means 36 (in the form of a hydraulic cylinder) for causing the guide ring 18 to rotate between the open and clamped positions is connected at one end to a lug 35 on the housing ring 16 and at the other end to a lug 37 on the guide ring 18.

A second means 38 (also in the form of a hydraulic cylinder) is connected at one end to the frame 14 and at the other end to the lug 35 on the housing ring 16 to rotate the housing ring 16 relative to the frame 14 and thereby, in use, to rotate a pipe section 12 clamped by the cams 20.

The housing ring rotating means 38 is arranged to actuate only when a predetermined force is applied to the guide ring 18 by the guide ring rotating means 36. Should such applied force fall below the predetermined force, the housing ring rotating means 38 stops actuating and the guide ring rotating means 36 is again actuated to increase the applied force to the requisite level.

It will be appreciated that when two pipe sections 12 are threadably connected to each other, gripping one of the pipe sections in the non-turnable chuck and the second pipe section in the apparatus 10 and turning the housing ring 16 using the housing ring rotating means 38 causes the two pipe sections 12 to break the threaded pipe connection.

Turning to Figure 7, there is provided a second embodiment of a threaded connection breaking apparatus 110. This embodiment is similar to the first embodiment 10, but includes a cam tip 140 and a bore 142. Figure 7 is a cross-sectional view of the threaded connection breaking apparatus 110 taken along a similar plane as plane X-X in Figure 2.

Each cam 120 includes a cam tip 140 distal the point at which the cam 120 is pivotally connected by the pin 130 to the housing ring 116, which cam tip is pivotally secured to the cam 120. The cam tip 140 is substantially triangular defining a base adjacent the cam 130 and an apex. The surface of the cam tip facing the axis A-A is curved to form a concave surface, which is serrated. The radius of the curved, serrated surface is between 50 mm and 100 mm. In use, the serrated surface bears against a pipe extending axially through the housing rings 116

Each cam 120 defines a circular bay, whereas the cam tip 140 adjacent its base defines a circular protrusion that is sized and shaped to locate and rotate within the bay. This pivotal connection permits the cam tip 140 to pivot relative to the cam 120 by between 10

and 30 degrees (preferably, between 15 degrees and 25 degrees). It will be appreciated that, the circular bay and protrusion could alternatively be defined by / formed on the cam tip 140 and cam 120, respectively.

The apex of the cam tip 140 has an angle between 5 degrees and 25 degrees. And, the cam tip 140 is made from a harder material than the material from which the cam 120 is made.

The bore 142 defined by the guide ring 118 extends linearly from the radial outer periphery of the guide ring 118 to the ramp 124 at a point outside the recess 128. The radial outer periphery of the guide ring 118 defines a notch 144 adjacent the bore 142 so as to provide a planar surface that is normal to the longitudinal axis of the bore 142. The internal surface of the bore 142 could be threaded, or a nut could be secured to the guide ring 118 within the notch 144. A bolt 146 sized and shaped to fit within the bore 142 and having a threaded portion for co-operating with the threaded portion of the bore 142 is insertable within the bore 142 and movable between: (i) a retracted position in which the bolt 146 does not protrude radially inwards from the radial inner periphery of the guide ring 118; and (ii) an extended position in which the bolt 146 protrudes radially inwards from the radial inner periphery of the guide ring 118 and abuts a cam 120 while the guide ring 118 is in the clamped position, thereby locking the cam 120 and guide ring in the clamped position. When the bolt 146 is in the extended position, the bolt enables the cam 120 to apply increased torque to a drill string 112 received within the guide ring 118.

CLAIMS

1. Apparatus for breaking threaded pipe connections including:

a housing ring that is, in use, rotatably connected to a frame, the housing ring defining an aperture for, in use, receiving a pipe section therethrough;

at least three cams pivotally connected to the housing ring;

a guide ring rotatable relative to the housing ring between an open position in which the cams are, in use, radially spaced from a pipe section extending therebetween and a clamped position in which the cams, in use, engage with and clamp the pipe section, the guide ring:

defining at least three ramps, each ramp causing a corresponding cam to ride up the ramp, pivot and protrude radially inwards as the guide ring is rotated from the open position to the clamped position; and

including at least three fingers that bear against the cams to cause the cams to pivot and retract radially outwards as the guide ring is rotated from the clamped position to the open position,

wherein at least a portion of each ramp and corresponding finger forming a recess defined by the guide ring that receives at least a portion of the corresponding cam therein when the guide ring is in the open position.

2. Threaded connection breaking apparatus according to claim 1, wherein the guide ring is sandwiched between a pair of housing rings.
3. Threaded connection breaking apparatus according to claim 2, wherein the recess is enclosed between the housing rings to form a cavity.
4. Threaded connection breaking apparatus according to claim 3, wherein the ramps, fingers and cams are sized and shaped such that when the guide ring is in the open position, the fingers limit pivoting of the cams to less than 30 degrees.

5. Threaded connection breaking apparatus according to claim 3, wherein the ramps, fingers and cams are sized and shaped such that when the guide ring is in the open position, the fingers limit pivoting of the cams to less than 20 degrees.
6. Threaded connection breaking apparatus according to claim 3, wherein the ramps, fingers and cams are sized and shaped such that when the guide ring is in the open position, the fingers limit pivoting of the cams to less than 10 degrees.
7. Threaded connection breaking apparatus according to claim 3, wherein the ramps, fingers and cams are sized and shaped such that when the guide ring is in the open position, the fingers limit pivoting of the cams to less than 5 degrees.
8. Threaded connection breaking apparatus according to claim 7 further including a means for causing the guide ring to rotate between the open and clamped positions.
9. A threaded connection breaking apparatus according to claim 8 further including a frame.
10. Threaded connection breaking apparatus according to claim 9 further including means for causing the housing ring to rotate relative to the frame thereby, in use, to rotate a pipe section clamped by the cams.
11. Threaded connection breaking apparatus according to claim 9, wherein operation of the housing ring rotating means is conditional upon the guide ring rotating means exerting and maintaining a predetermined force upon the guide ring.
12. Threaded connection breaking apparatus according to claim 11, wherein each cam includes a cam tip distal the point at which the cam is pivotally connected to the housing ring, which cam tip is pivotally secured to the cam.
13. Threaded connection breaking apparatus according to claim 12, wherein one surface of the cam tip is serrated.

14. Threaded connection breaking apparatus according to claim 13, wherein the serrated surface is curved to form a concave with a radius between 50 mm and 100 mm.
15. Threaded connection breaking apparatus according to claim 14, wherein one of the cam and the cam tip defines a circular bay and the other of the cam and the cam tip defines a circular protrusion sized and shaped to locate and rotate within the bay.
16. Threaded connection breaking apparatus according to claim 15, wherein the cam tip is pivotal relative to the cam by between 10 degrees and 30 degrees.
17. Threaded connection breaking apparatus according to claim 15, wherein the cam tip is pivotal relative to the cam by between 15 degrees and 25 degrees.
18. Threaded connection breaking apparatus according to claim 17, wherein the cam tip is substantially triangular defining an apex distal the point of connection with the cam having an angle between 5 degrees and 25 degrees.
19. Threaded connection breaking apparatus according to claim 18, wherein the cam tip is made from a harder material than the material from which the cam is made.
20. Threaded connection breaking apparatus according to claim 19, wherein the guide ring defines a bore that extends linearly from the radial outer periphery of the guide ring to the ramp at a point outside the recess.
21. Threaded connection breaking apparatus according to claim 20, wherein the radial outer periphery of the guide ring defines a notch adjacent the bore so as to provide a planar surface that is normal to the longitudinal axis of the bore.
22. Threaded connection breaking apparatus according to claim 21, wherein a threaded portion is associated with the bore for co-operating with a threaded portion on a bolt sized to be received within the bore.
23. Threaded connection breaking apparatus according to claim 22, wherein the bolt is movable between: (i) a retracted position in which the bolt does not protrude radially inwards from the radial inner periphery of the guide ring; and (ii) an extended position in which the bolt protrudes radially inwards from the radial inner periphery

of the guide ring and abuts a cam while the guide ring is in the clamped position, thereby locking the cam and guide ring in the clamped position.

24. Threaded connection breaking apparatus according to claim 23 further including a port associated with each cavity, the ports: (i) being defined by the housing ring and/or the guide ring; and (ii) facilitating the ejection of accumulated dirt from the cavity as the cam is received therein.
25. Threaded connection breaking apparatus according to claim 24, wherein each cam is connected to the pair of housing rings by a pin spanning between the housing rings and extending through a bore defined by the cam.
26. Threaded connection breaking apparatus according to claim 25, wherein the ramps define a square aperture in the guide ring with recesses extending from corners of the square aperture.

1/6

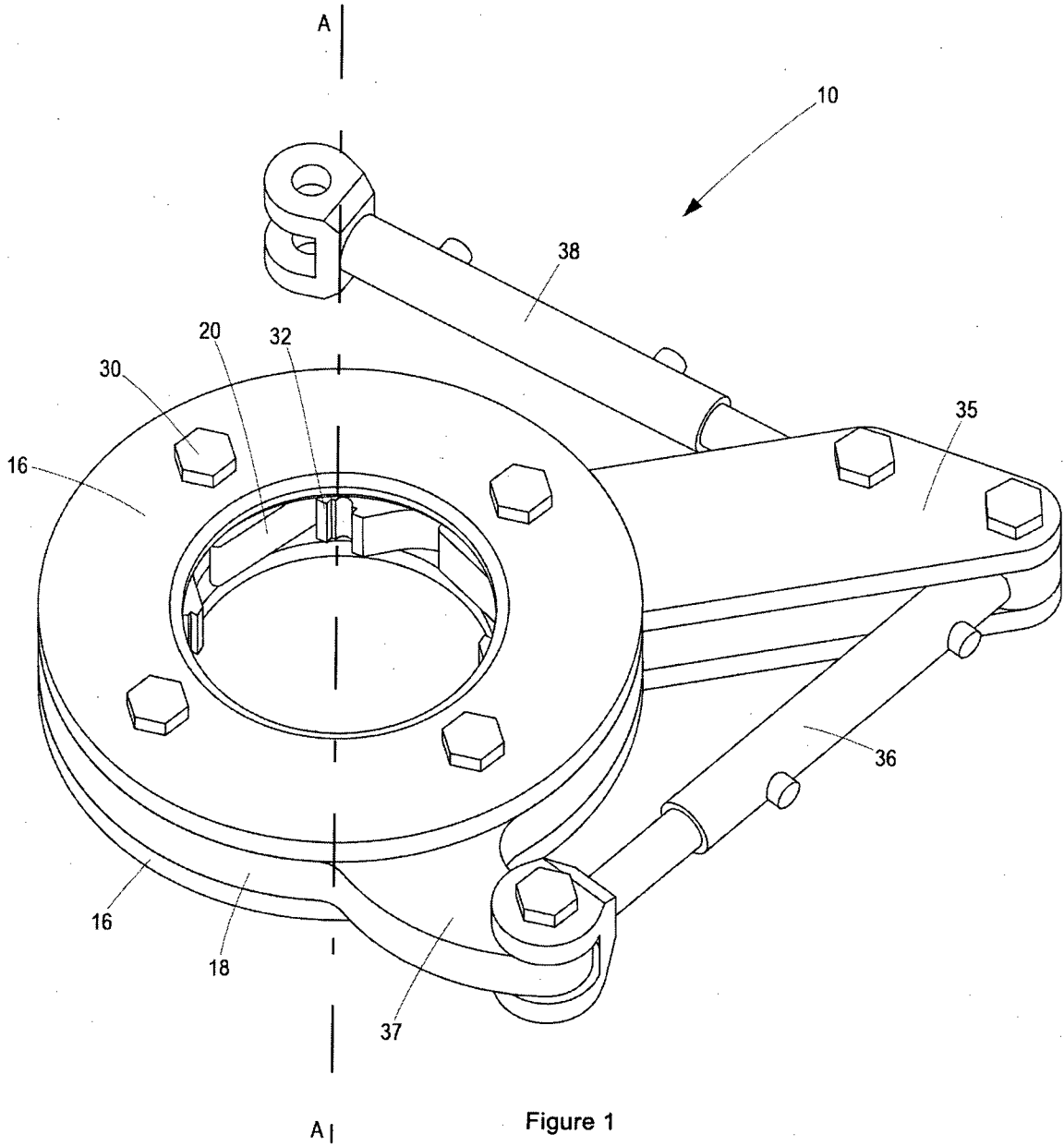


Figure 1

2/6

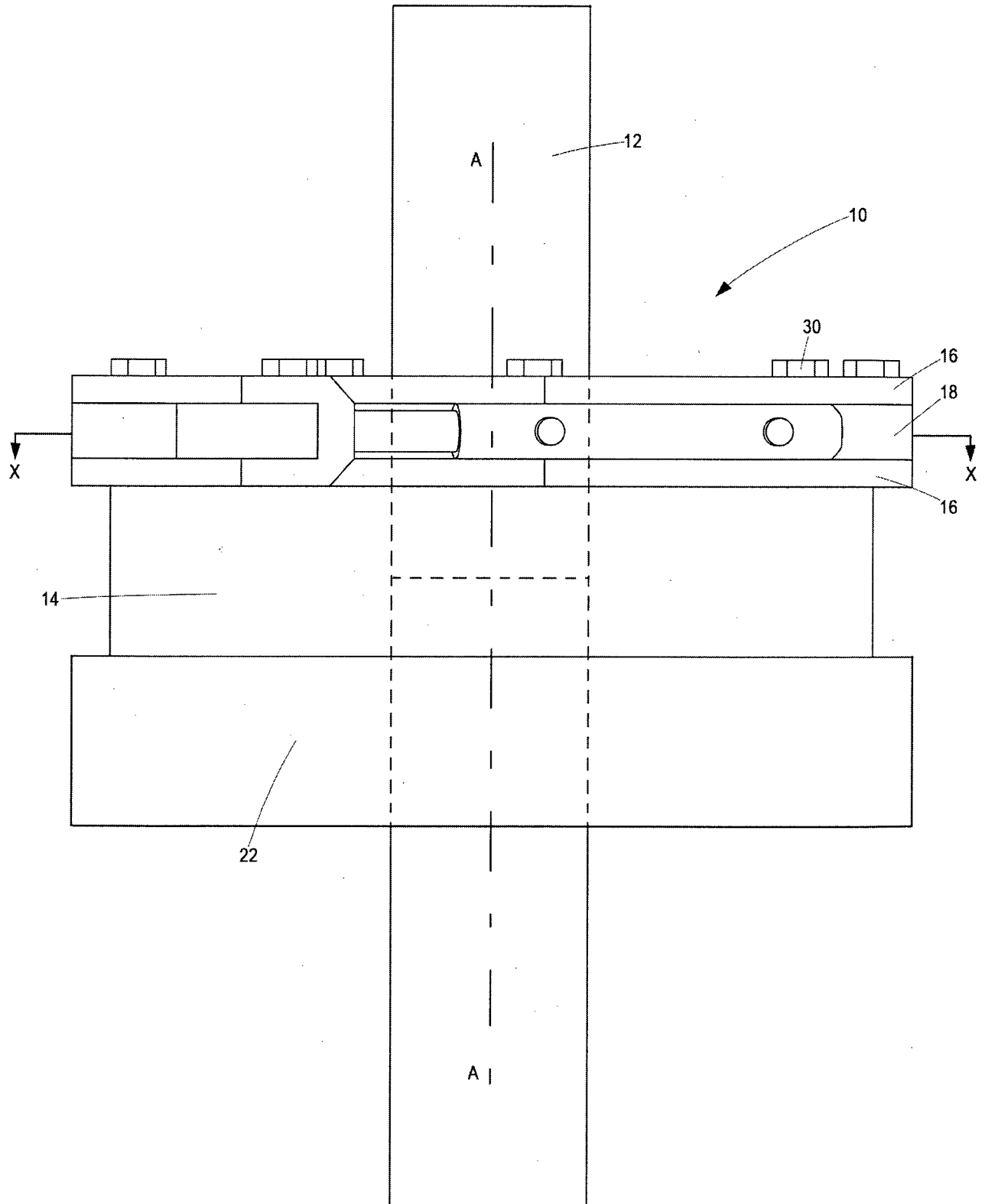


Figure 2



3/6

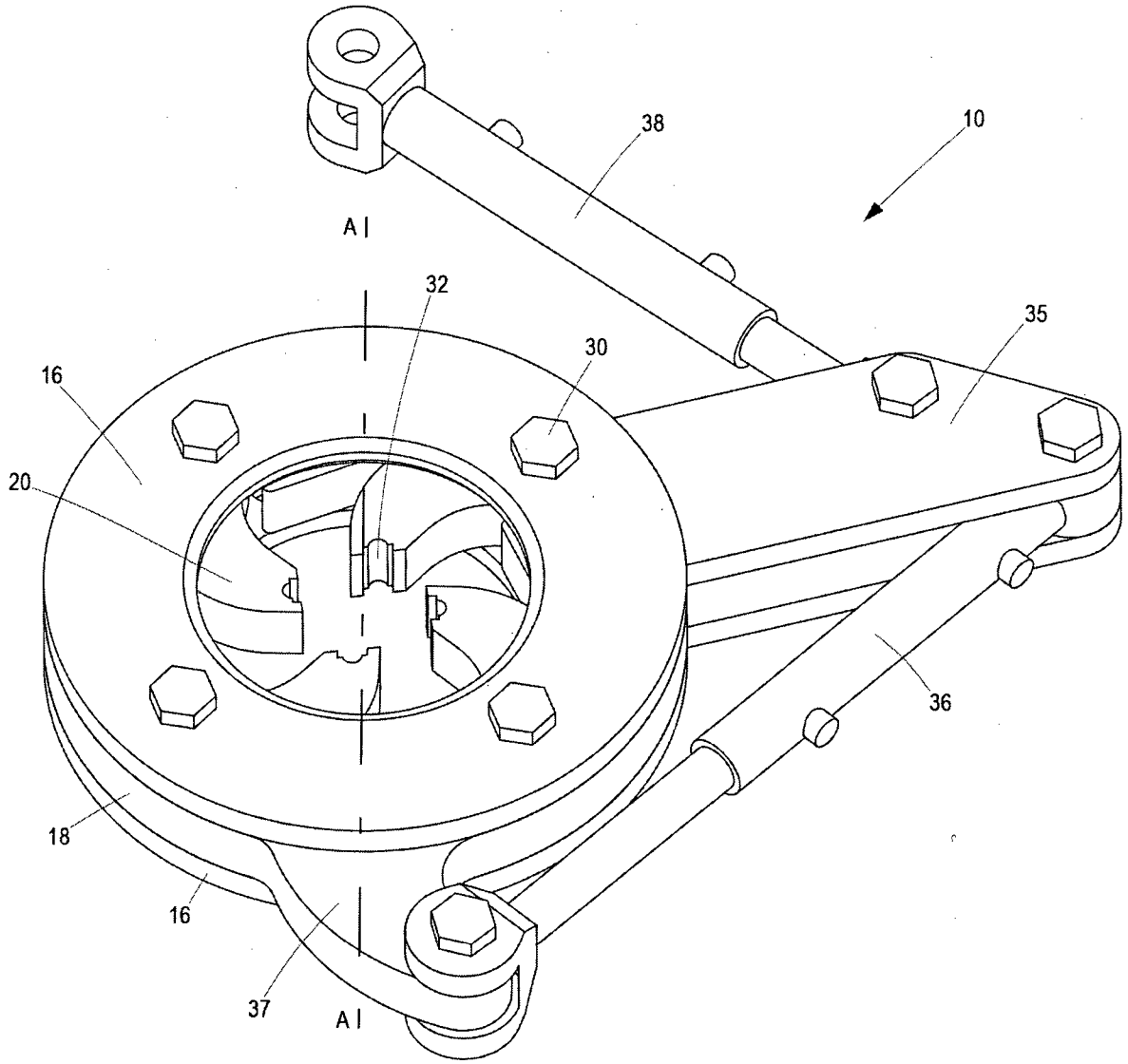


Figure 3

4/6

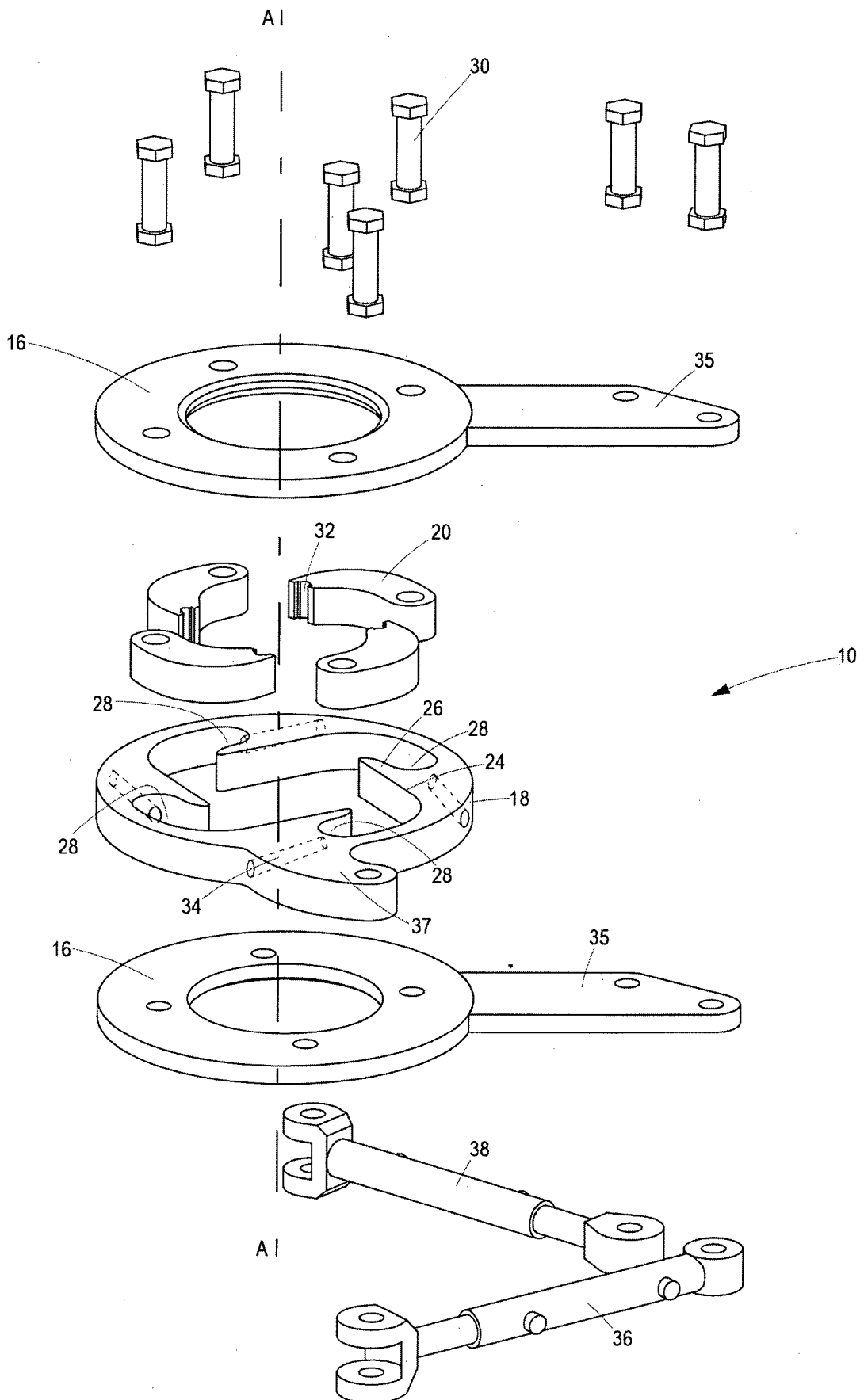


Figure 4

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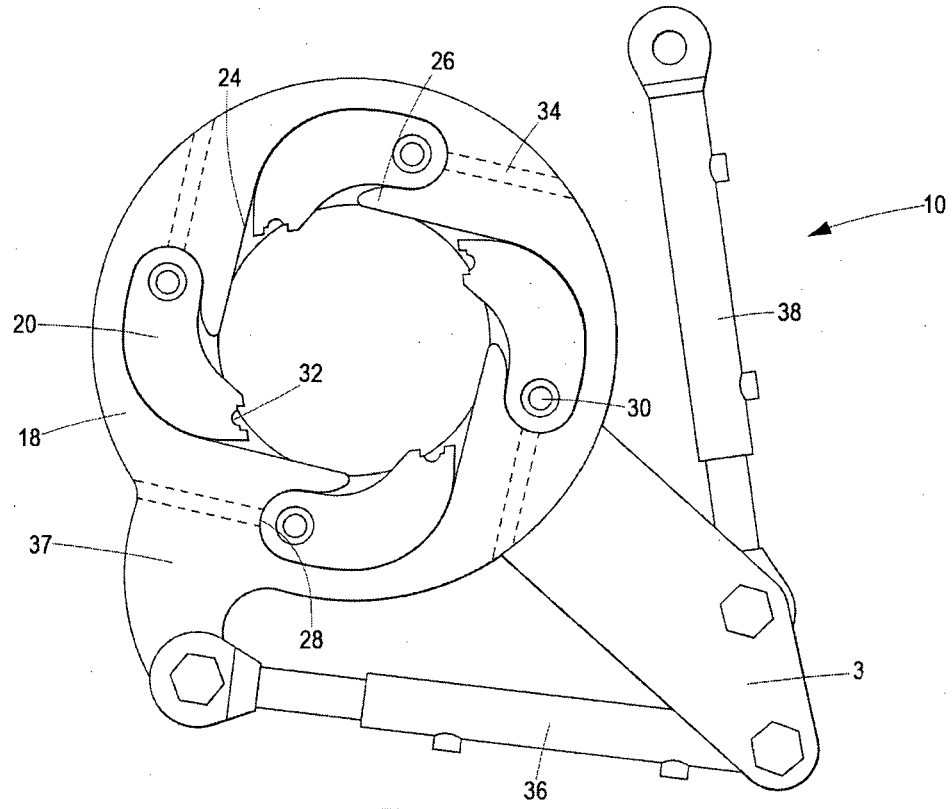


Figure 5

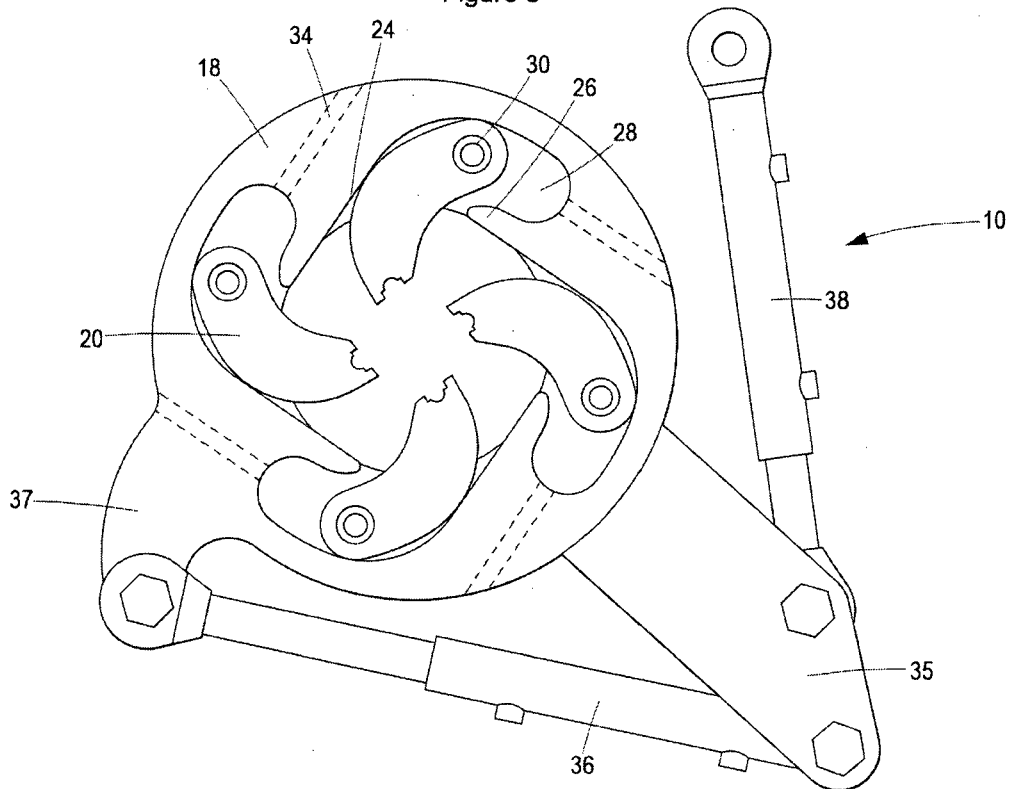


Figure 6

6/6

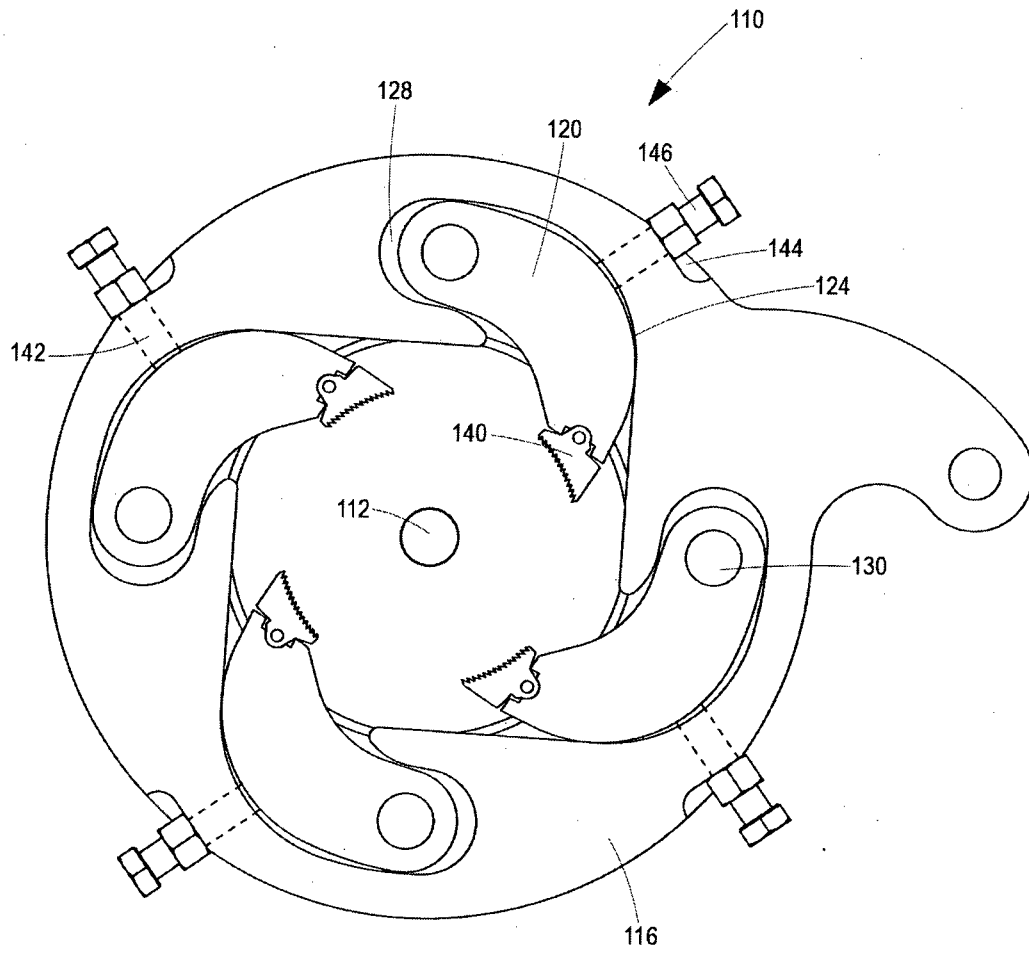


Figure 7

**INTERNATIONAL SEARCH REPORT**

International application No.

PCT / ZA 2013/000075

<p>A. CLASSIFICATION OF SUBJECT MATTER                  IPC: <b>E21B 19/16</b> (2006.01)                  According to International Patent Classification (IPC) or to both national classification and IPC</p>		
<p>B. FIELDS SEARCHED                  Minimum documentation searched (classification system followed by classification symbols)                  E21B, B25B                  Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched</p>		
<p>Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)                  EPODOC, WPI</p>		
<p>C. DOCUMENTS CONSIDERED TO BE RELEVANT</p>		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 2012009383 A2 (MUSEMECHE) 19 January 2012 (19.01.2012) figures	1-26
A	EP 0170195 B1 (ECKEL MANUFACTURING COMPANY; INC.) 30 November 1988 (30.11.1988) figures	1-26
A	US 2008022811 A1 (KATHAN) 31 January 2008 (31.01.2008) figures	1-26
<p><input type="checkbox"/> Further documents are listed in the continuation of Box C. <input checked="" type="checkbox"/> See patent family annex.</p>		
<p>* Special categories of cited documents:</p> <p>“A” document defining the general state of the art which is not considered to be of particular relevance</p> <p>“E” earlier application or patent but published on or after the international filing date</p> <p>“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)</p> <p>“O” document referring to an oral disclosure, use, exhibition or other means</p> <p>“P” document published prior to the international filing date but later than the priority date claimed</p> <p>“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</p> <p>“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</p> <p>“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</p> <p>“&amp;” document member of the same patent family</p>		
<p>Date of the actual completion of the international search                  21 January 2014 (21.01.2014)</p>		<p>Date of mailing of the international search report                  27 January 2014 (27.01.2014)</p>
<p>Name and mailing address of the ISA/AT                  Austrian Patent Office                  Dresdner Straße 87, A-1200 Vienna                  Facsimile No. +43 / 1 / 534 24-535</p>		<p>Authorized officer                  WANKMÜLLER A.                  Telephone No. +43 / 1 / 534 24-415</p>

**INTERNATIONAL SEARCH REPORT**  
Information on patent family members

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PCT / ZA 2013/000075

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