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(72) Inventor(s):
MARKKU KESKINIVA

(73) Proprietor(s):
MINCON INTERNATIONAL LIMITED
Co. Clare
Ireland

(74) Agent and/or Address for Service:
TOMKINS & CO.
5 Dartmouth Road
Dublin 6
Ireland

RELEASE ASSEMBLY FOR PERCUSSION DRILL TOOLS

Field of the Invention

The present invention relates to a release assembly for fluid-operated percussion drill tools. In particular, the invention concerns a release assembly for use with "down-the-hole" hammers.

Background to the Invention

Some designs of conventional down-the-hole hammer and fluid-operated percussion drill tools comprise an external cylinder or outer wear sleeve, within which is mounted an inner cylinder which in turn engages with a backhead assembly. A sliding reciprocating piston co-operates with the inner cylinder and backhead assembly, which when air pressure is supplied through the backhead assembly, acts with a percussive effect on a drill bit retained within a chuck on the outer wear sleeve.

Typically, various components of the hammer are screw-threadably connected to one another. For example, the chuck may be screw-threadably connected to the bottom of the outer wear sleeve. An upper portion of the chuck is externally screw-threaded for engagement with a complementary internal screw thread on the lower end of a wear sleeve of the drill tool.

During drilling operation, the screw-threaded connection between components of the hammer can occasionally become over-tightened due to the percussive force to such an extent that it is not possible to disconnect the components, after drilling, in a normal manner.

European Patent Application Publication No. EP 2 868 861 relates to a release assembly and method of forming a drilling tool. The release assembly is intended to be arranged axially between two drilling tool components, which can be connected together at a joint by means of connecting threads. The assembly comprises a release mechanism that allows an axial length of the assembly to be shortened in response to turning the connecting threads of the joint in an opening direction. A disadvantage of this

arrangement is that the thread connection may open unintentionally during drilling. Also, the geometry of the components is such that they are challenging to manufacture.

Summary of the Invention

According to an aspect of the present disclosure, there is provided a release assembly disposable axially between two components of a percussion drill tool, wherein the components are connectable together by means of a screw-threaded connection, the release assembly comprising:

a release ring, the release ring being tapered on at least a first side in a first radial direction;

a first counter element arranged axially adjacent the first side of the release ring, the first counter element having a tapered side for engagement with the first side of the release ring.

Preferably, the release ring comprises a plurality of separate sectors, or a single element divisible or adapted to be divided into a plurality of separate sectors, such that the sectors of the release ring are moveable in a second radial direction opposite to the first radial direction to shorten an axial length of the release assembly, that is, an axial length (or height) of the release assembly may be reduced by effecting radial movement of the release ring in a second radial direction opposite to the first radial direction. Thus, the release ring is moveable from a first configuration in which the release assembly has a first axial length to a second configuration in which the release assembly has a second axial length, and the first axial length is greater than the second axial length.

Shortening of the axial length of the release assembly reduces the forces preventing disconnection of the screw-threaded connection, thereby allowing the connection to be opened.

In certain embodiments, the release ring is tapered on a first side and a second side, and the release assembly further comprises a second counter element arranged axially adjacent the second side of the release ring, the second counter element having a tapered side for engagement with the second side of the release ring.

Preferably, the taper of the release ring and the counter elements is smooth, that is, the axial height of the release ring and counter elements decreases continuously in the first radial direction. However, in certain embodiments, the taper of either the release ring or the corresponding counter element may be stepwise or grooved taper, that is, the axial height of the release ring or counter element decreases in steps or at intervals in the first radial direction.

In one embodiment, the first radial direction is an outward direction and the second radial direction is an inward direction. The term "inward" is used herein to refer to a radial direction towards a central longitudinal axis of the percussion drill tool. The term "outward" is used herein to refer to a radial direction away from a central longitudinal axis of the percussion drill tool. That is, an axial length (or height) of the release ring decreases from an inner circumference of the ring to an outer circumference of the ring, and the release ring is moveable inwards to shorten or reduce the axial length of the release assembly. A radial clearance ΔR may be provided between an inner circumference of the release ring and an outer circumference of one of the components. For example, the release ring may be radially shorter than the or each counter element. Alternatively or additionally, removable means, such as set screws, may be provided to maintain the radial clearance ΔR between an inner circumference of the release ring and a component of the percussion drill tool prior to deployment of the release assembly. When the assembly is to be deployed, the removable means are removed to allow the release ring to be moved inwards. The release ring may comprise at least three separate sectors, or a single element divisible into at least three separate sectors, and a circumferential clearance is provided between adjacent sectors. The circumferential clearance allows the sectors of the release ring to be moved inwards.

In another embodiment, the first direction is an inward direction and the second direction is an outward direction. That is, an axial length (or height) of the release ring decreases from an outer circumference of the ring to an inner circumference of the ring, and the release ring is moveable outwards to shorten or reduce the axial length of the release assembly.

The release ring may comprise a plurality of separate sectors.

Alternatively, the release ring may comprise a single element, divisible into a plurality of separate sectors in situ, that is, while the release assembly is disposed between the components of the drill tool. The release ring may comprise a plurality of weakened regions spaced around the circumference of the ring, such that the ring is adapted to be divided into a plurality of sectors at the weakened regions. Each weakened region may comprise a portion of reduced thickness spaced around the circumference of the ring, such that the ring is divisible into a plurality of separate sectors at portions of reduced thickness. The radial length of the release ring may be reduced at the weakened regions.

Preferably, the release ring comprises, or is divisible into, at least three sectors. Each of the sectors may be moveable independently of the other sectors.

In embodiments where the release ring is moveable inwards to shorten the axial length of the release assembly, a circumferential clearance may be provided between the sectors.

The or each counter element may be integrally formed with one of the components of the drill tool.

According to another aspect of the present disclosure, there is provided a method for releasing components of a percussion drill tool, wherein the components are connectable together by means of a screw-threaded connection, the method comprising:

disposing a release assembly axially between two components of a percussion drill tool, wherein the release assembly comprises a release ring tapered on at least a first side in a first radial direction and a first counter element arranged axially adjacent the first side of the release ring, the first counter element having a tapered side for engagement with the first side of the release ring;

connecting the components together by means of a screw-threaded connection; and

deploying the release assembly by dividing the release ring into a plurality of sectors and moving the sectors of the release ring in a second radial direction opposite to the first radial direction to shorten an axial length of the release assembly.

According to another aspect of the present disclosure, there is provided a method for releasing a screw-threaded connection between components of a percussion drill tool, the method comprising:

disposing a release assembly axially between two components of a percussion drill tool, wherein the release assembly comprises a release ring tapered on at least a first side in a first radial direction, wherein the release ring comprises a plurality of separate sectors, and a first counter element arranged axially adjacent the first side of the release ring, the first counter element having a tapered side for engagement with the first side of the release ring;

connecting the components together by means of a screw-threaded connection; and

deploying the release assembly by moving the sectors of the release ring in a second radial direction opposite to the first radial direction to shorten an axial length of the release assembly.

Brief Description of the Drawings

Figure 1a is a radial cross-section of a release assembly according to an embodiment of the present invention, disposed axially between component A and component B of a percussion drill tool, prior to deployment;

Figure 1b is an axial cross-section of the release assembly of Figure 1a;

Figure 1c is a radial cross-section of the release assembly of Figure 1a, after deployment;

Figure 1d is an axial cross-section of the release assembly of Figure 1c;

Figure 2a is a radial cross-section of a release assembly according to an embodiment of the present invention, where the release ring is formed as a single element;

Figure 2b is a radial cross-section of the release assembly of Figure 2a, after division of the release ring into sectors;

Figures 3a, 3b and 3c are radial cross-sections of release assemblies according to various embodiments of the present invention, before deployment;

Figure 3d is a radial cross-section of the release assembly of Figure 3a, after deployment;

Figure 3e is a radial cross-section of the release assembly of Figure 3b, after deployment;

Figure 4 is a radial cross-section of a release assembly according to an embodiment of the present invention, disposed axially between two components of a percussion drill tool, wherein the counter elements are integrally formed with the components;

Figures 5a to 5h show a release assembly according to an embodiment of the present invention, in which the counter elements are reusable after deployment; and

Figure 6 is an axial cross-section of a release assembly according to an aspect of the present invention, in which the release ring and counter elements are reusable after deployment.

Detailed Description of the Drawings

Referring initially to Figures 1a and 1b, there is illustrated a release assembly 100 according to an embodiment of the invention, disposed axially between component A and component B of a percussion drill tool 10. Components A and B are connected together by means of a screw-threaded connection 20.

The release assembly comprises a release ring 102. In the embodiment shown, the release ring 102 is tapered on both first 103 and second sides 104 in an outward direction, that is, the axial height of the ring at its outer circumference is smaller than the axial height of the ring at its inner circumference. The release assembly also comprises a first counter element 105 arranged axially above the first side 103 of the release ring and a second counter element 107 arranged axially below the second side 104 of the release ring. The first counter element 105 has an inwardly tapered side 106 for engagement with the first side 103 of the release ring and a substantially planar side 109 in contact with component B. The second counter element 107 has an inwardly tapered side 108 for engagement with the second side 104 of the release ring and a substantially planar side 110 in contact with component A. As shown in Figure 1a, the co-operation of structure between the release ring and the counter elements is such that the release assembly is substantially cylindrical having planar upper 109 and lower surfaces 110 prior to deployment.

As shown in Figure 1b, the release ring 102 is radially shorter than the counter elements 105, 107 by a radial clearance ΔR. Figure 1b also illustrates that the release ring comprises a plurality of separate sectors 102a, 102b, 102c, 102d. A circumferential clearance ΔC is provided between adjacent sectors.

Figures 1c and 1d show the release assembly of Figures 1a and 1b after deployment. To deploy the release assembly, the sectors of the release ring 102 are moved in an inward direction through a distance of ΔR, as shown by the arrows in Figure 1d, to shorten an axial length (or height) of the release assembly by a distance ΔH. The sectors may be pushed inwards using a hammer and a suitable tool. The circumferential clearances ΔC facilitate inward movement of the sectors and after deployment, the clearance is reduced (or eliminated). After deployment, the axial forces on the threaded connection will be reduced due to the decreased axial length of the release assembly, which allows side 109 of counter element 105 to move out of contact with component B, thereby allowing the thread to be opened more easily. In this embodiment of the invention, the release ring and counter elements remain intact after deployment and so the release assembly make be reused.

To perform a method for releasing a screw-threaded connection between components of a percussion drill tool, the following steps may be performed. First, release assembly 100 is disposed axially between two components A and B of a percussion drill tool. As described above, release assembly 100 comprises a release ring 102 outwardly tapered on both sides and comprising a plurality of separate sectors 102a, 102b, 102c, 102d, and counter elements 105 and 107 arranged axially adjacent either side of the release ring, each counter element having a tapered side for engagement with the adjacent side of the release ring. Next, the components A and B are connected together by means of a screw-threaded connection. After using the percussion drill tool, the release assembly 100 is deployed by moving the sectors 102a, 102b, 102c and 102d of the release ring inwards to shorten an axial length of the release assembly.

Another embodiment of a release assembly according to the present invention is shown in Figures 2a and 2b. The release assembly 200 comprises a release ring 202. As in the previous embodiment, the release ring 202 is tapered on both first 203 and second sides

204 in an outward direction. The release assembly also comprises a first counter element 205 arranged axially above the first side 203 of the release ring and a second counter element 207 arranged axially below the second side 204 of the release ring. The first counter element 205 has an inwardly tapered side 206 for engagement with the first side 203 of the release ring. The second counter element 207 has an inwardly tapered side 208 for engagement with the second side 204 of the release ring. Sides 209 and 210 of the counter elements are substantially planar, and in use, are in contact with the components of the percussion drill tool prior to deployment.

In this embodiment, as shown in Figure 2a, the release ring 202 is formed as a single element. To deploy the release assembly, the release ring is divided into a plurality of separate sectors in situ, of which sectors 202a and 202b are shown in Figure 2a. This may be achieved, for example, by drilling holes into the release ring at a plurality of points around the circumference thereof in a radially inward direction, wherein the hole diameter is greater than the maximum axial length (thickness) H of the release ring. The drilling also creates the circumferential clearance ΔC between the sectors. The holes are preferably evenly spaced around the circumference of the release ring. The sectors of the release ring may then be moved as described above with reference to Figure 1. In this embodiment, the counter elements are destroyed during drilling of the release ring, and the release assembly is therefore not reusable.

To perform a method for releasing a screw-threaded connection between components of a percussion drill tool, the following steps may be performed. First, release assembly 200 is disposed axially between two components A and B of a percussion drill tool. As described above, the release assembly 200 comprises a release ring 202 outwardly tapered on both upper and lower sides and counter elements 205 and 207 arranged axially adjacent either side of the release ring, each counter element having a tapered side for engagement with the adjacent side of the release ring. Next, the components are connected together by means of a screw-threaded connection. After using the percussion drill tool, the release assembly is deployed by dividing the release ring 202 into a plurality of sectors 202a, 202b and moving the sectors of the release ring inwards to shorten an axial length of the release assembly.

Various embodiments of release assemblies in accordance with the present invention are illustrated in Figure 3. Figure 3a illustrates a release assembly, similar to that described above with referenced to Figure 1, before deployment. Figure 3d shows the same release assembly after deployment.

Figure 3b illustrates a release assembly 300 according to an alternate embodiment of the invention, in which the release ring 302 is tapered on first 303 and second sides 304 in an inward direction. The release assembly 300 also comprises a first counter element 305 arranged axially above the first side 303 of the release ring and a second counter element 307 arranged axially below the second side 304 of the release ring. The first counter element 305 has an outwardly tapered side 306 for engagement with the first side 303 of the release ring. The second counter element 307 has an outwardly tapered side 308 for engagement with the second side 304 of the release ring. Sides 309 and 319 of the counter elements are substantially planar, and in use, are in contact with the components of the percussion drill tool prior to deployment. Figure 3b also illustrates that the release ring comprises a plurality of separate sectors, of which sectors 302a, 302b and 302c are shown.

Figure 3e shows the release assembly of Figure 3b after deployment. To deploy the release assembly, the sectors of the release ring 302 are moved in an outward direction, as shown by the arrows in Figure 3b, to shorten an axial length (or height) of the release assembly. This may be done by applying a pressure to the annulus between the drilling components and the release ring, which will push the release ring outwards. After deployment, the axial forces on the threaded connection will be reduced due to the decreased axial length of the release assembly, thereby allowing the threaded connection to be opened more easily.

Figure 3c illustrates a release assembly 310 according to an alternate embodiment of the invention, in which the release ring 312 is tapered on a first side 313 only in an outward direction. The release assembly 310 also comprises a first counter element 315 arranged axially above the first side 313 of the release ring and a second counter element 317 arranged axially below the release ring. The first counter element 315 has a tapered side 316 for engagement with the first side 313 of the release ring and a

substantially planar side 318 for engagement with a component of the drill. The release ring 312 is radially shorter than the counter elements 315, 317 by a radial clearance ΔR. Figure 3c also illustrates that the release ring comprises a plurality of separate sectors, of which sectors 312a, 312b and 312c are shown. A circumferential clearance ΔC is provided between adjacent sectors.

To deploy the release assembly of Figure 3c, the sectors of the release ring 312 are moved in an inward direction through a distance of ΔR, to shorten an axial length (or height) of the release assembly. The circumferential clearances ΔC facilitate inward movement of the sectors and after deployment, the circumferential clearance is reduced (or eliminated). After deployment, the axial forces on the threaded connection will be reduced due to the decreased axial length of the release assembly, thereby allowing the thread to be opened more easily.

In the embodiment shown in Figure 4, a release assembly 400 comprises a release ring 402 tapered in an outward direction. The release assembly also comprises a first counter element 405 arranged axially above the release ring and a second counter element 407 arranged axially below the release ring. The first counter element 405 has an inwardly tapered side 406 for engagement with the release ring. The second counter element 407 has an inwardly tapered side 408 for engagement with the release ring. In the embodiment shown in Figure 4, each counter element 405, 407 is integrally formed with one of the components of the drill tool.

Figures 5a to 5h illustrate a release assembly 500 according to another embodiment of the invention. In this embodiment, the release ring 502 is tapered on both sides in an outward direction, as described above with reference to Figure 1. The release assembly also comprises counter elements 503 and 505 arranged axially above and below the release ring 502 in use. In this embodiment, the release ring 502 is formed as a single element having a plurality of recesses 509 formed around the inner circumference 510 thereof. The radial length of the release ring is decreased at the recessed portions, as compared with the rest of the ring. The thickness of the ring at the recessed portions is uniform, and less than the thickness T_1 of the ring at the outer circumference of the non-recessed portions.

Figures 5e, 5f and 5g show the release ring 502 in the assembly 500. Figure 5e is an axial section of the release assembly 500 and Figure 5f is a radial section through line AA of Figure 5e. To deploy the release assembly, the release ring 502 is divided in situ into a plurality of separate sectors 502a, 502b, 502c and 502d, as shown in Figure 5d, by drilling holes into the release ring at the recessed portions 509 in the direction shown in Figure 5c. For a ring without reduced thickness portions, the minimum hole diameter required to separate the ring into sectors would be equal to the maximum thickness of the ring T_2. Because the thickness of the release ring of Figure 5 is reduced at the recessed portions, the hole diameter required to separate the ring into sectors is also reduced. Thus, the ring 502 can be divided without destroying the counter elements 503, 505. This may be particularly useful in embodiments where the counter elements are integrally formed with the drill components. Because the radial length of the release ring is reduced at the recessed portions, the drilling distance required to separate the segments is also reduced. Once the ring has been separated, the sectors of the release ring may be pushed inwards as described above with reference to Figure 1. As shown in Figure 5h, pilot holes 510 may be provided at the recessed portions to allow the positions of the recessed portions to be easily identified and drilled when the release assembly is in situ.

Another embodiment of the invention is shown in Figure 6. In this embodiment, a plurality of set screws 610 are provided in order to maintain a radial clearance ΔR between an inner circumference 611 of the release ring 602 and a component of the drill tool prior to deployment. To deploy the release mechanism, the set screws 610 are removed or adjusted so that the sectors 602a, 602b, 602c, 602d of the release ring may be pushed inwards in order to create the axial clearance ΔH. In this embodiment, all of the components of the release assembly are reusable.

The words "comprises/comprising" and the words "having/including" when used herein with reference to the present invention are used to specify the presence of stated features, integers, steps or components but does not preclude the presence or addition of one or more other features, integers, steps, components or groups thereof.

It is appreciated that certain features of the invention, which are, for clarity, described in the context of separate embodiments, may also be provided in combination in a single embodiment. Conversely, various features of the invention which are, for brevity, described in the context of a single embodiment, may also be provided separately or in any suitable sub-combination.

Claims

1. A release assembly disposable axially between two components of a percussion drill tool, wherein the components are connectable together by means of a screw-threaded connection, the release assembly comprising:

a release ring, the release ring being tapered on at least a first side in a first radial direction;

a first counter element arranged axially adjacent the first side of the release ring, the first counter element having a tapered side for engagement with the first side of the release ring.

2. A release assembly as claimed in claim 1, wherein the release ring comprises a plurality of separate sectors, or a single element divisible into a plurality of separate sectors, such that the sectors of the release ring are moveable in a second radial direction opposite to the first radial direction to shorten an axial length of the release assembly.

3. A method for releasing a screw-threaded connection between components of a percussion drill tool, the method comprising:

disposing a release assembly axially between two components of a percussion drill tool, wherein the release assembly comprises a release ring tapered on at least a first side in a first radial direction and a first counter element arranged axially adjacent the first side of the release ring, the first counter element having a tapered side for engagement with the first side of the release ring;

connecting the components together by means of a screw-threaded connection; and

deploying the release assembly by dividing the release ring into a plurality of sectors and moving the sectors of the release ring in a second radial direction opposite to the first radial direction to shorten an axial length of the release assembly.

4. A method for releasing a screw-threaded connection between components of a percussion drill tool, the method comprising:

disposing a release assembly axially between two components of a percussion drill tool, wherein the release assembly comprises a release ring tapered on at least a first side in a first radial direction, wherein the release ring comprises a plurality of separate sectors, and a first counter element arranged axially adjacent the first side of the release ring, the first counter element having a tapered side for engagement with the first side of the release ring;

connecting the components together by means of a screw-threaded connection; and

deploying the release assembly by moving the sectors of the release ring in a second radial direction opposite to the first radial direction to shorten an axial length of the release assembly.

5. A release assembly substantially as hereinbefore described with reference to and/or as illustrated in the accompanying drawings.

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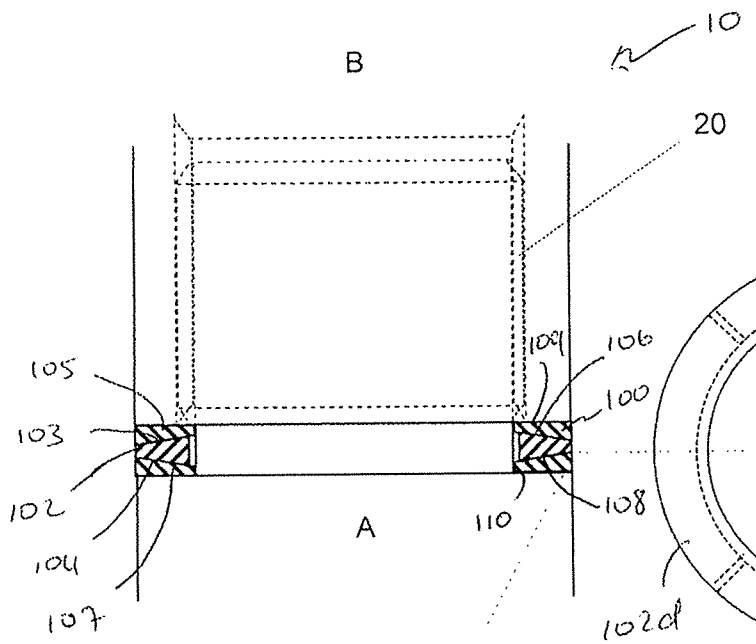

Figure 1a

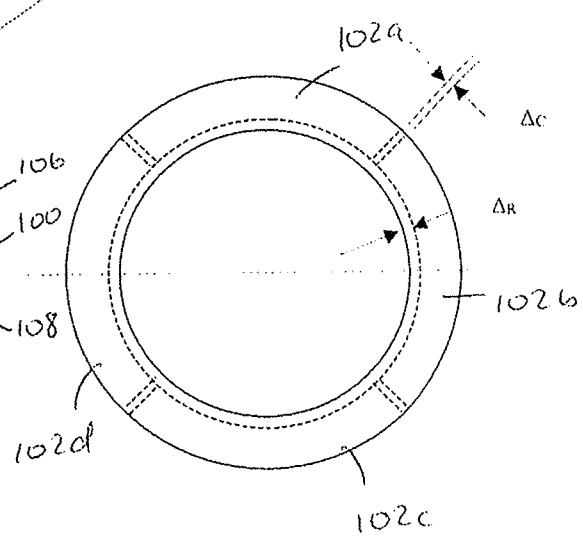

Figure 1b

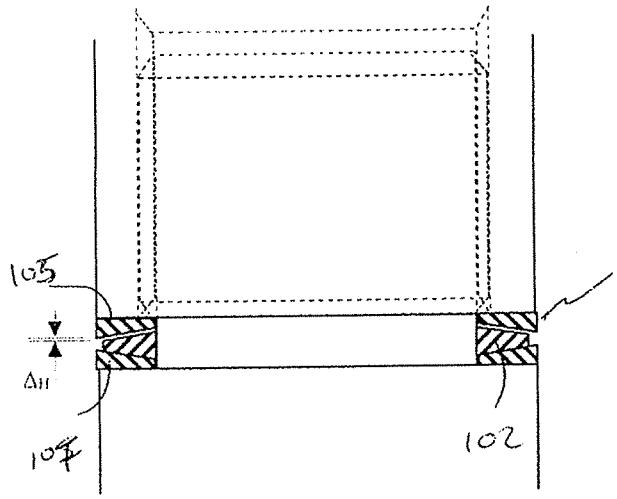

Figure 1c

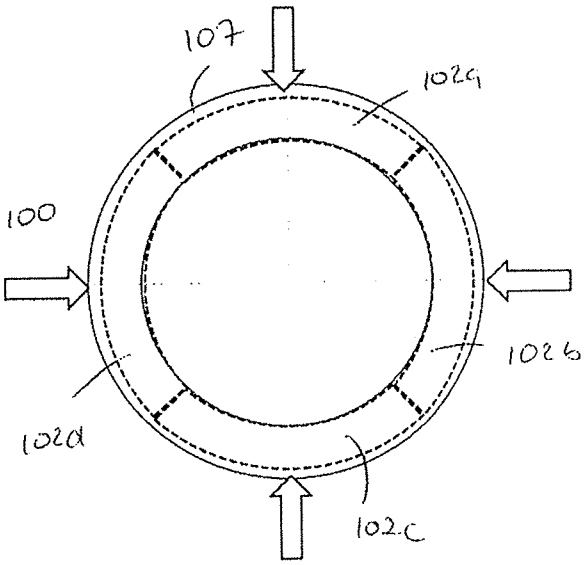

Figure 1d

Figure 1

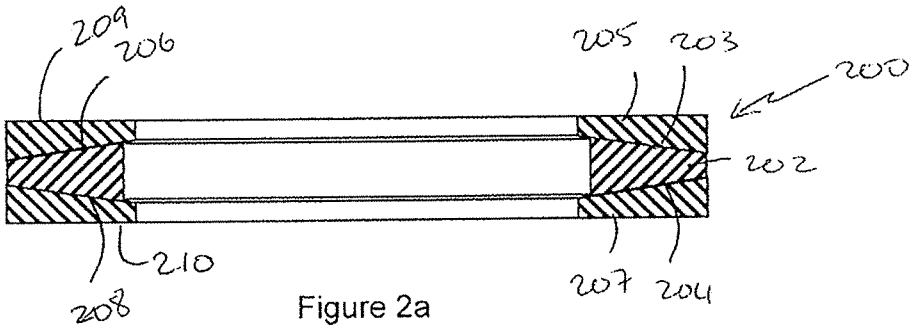

Figure 2a

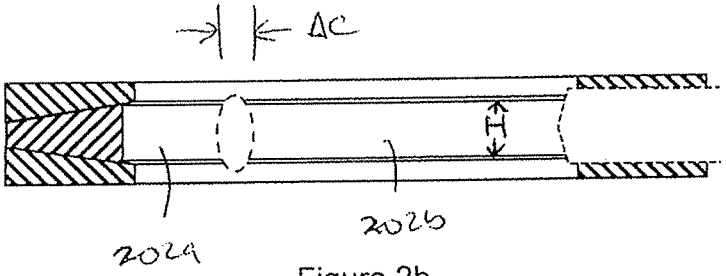

Figure 2b

Figure 2

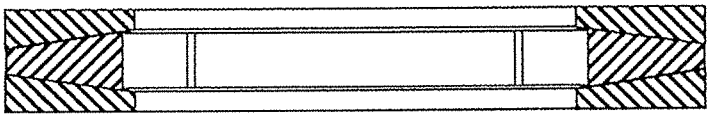

Figure 3a

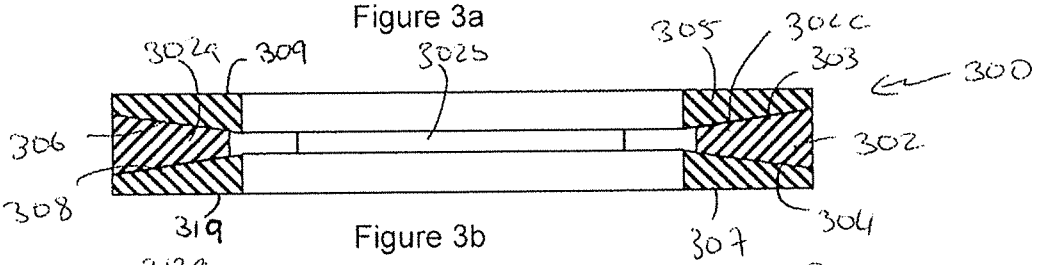

Figure 3b

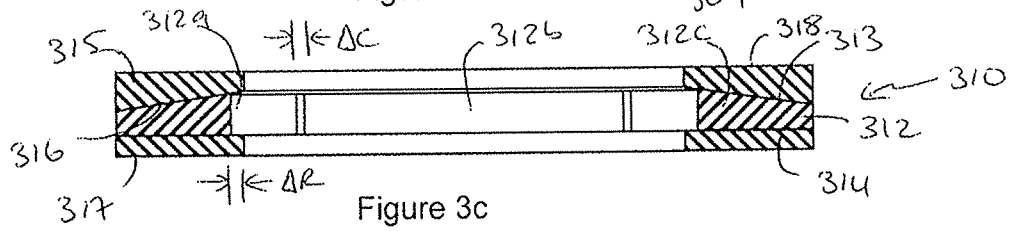

Figure 3c

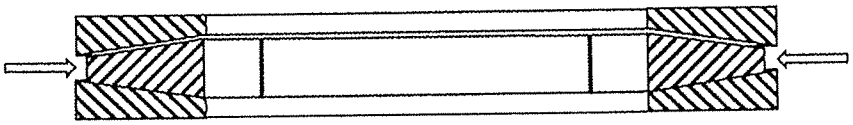

Figure 3d

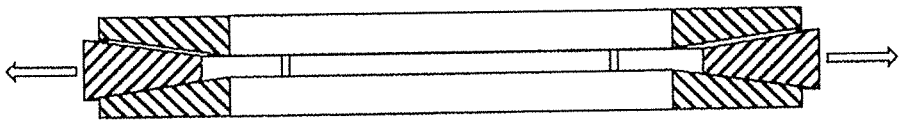

Figure 3e

Figure 3

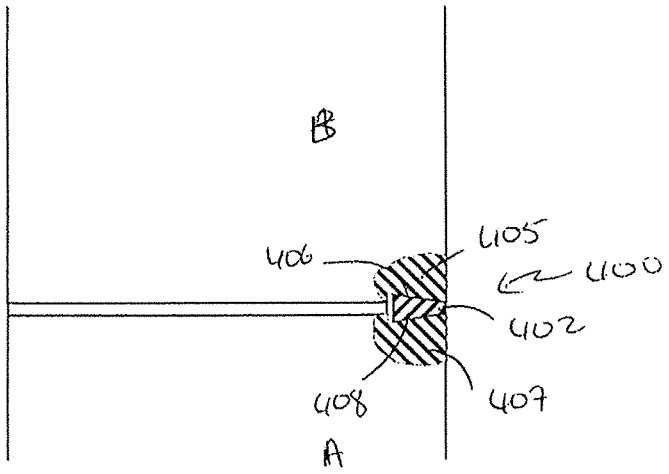

Figure 4

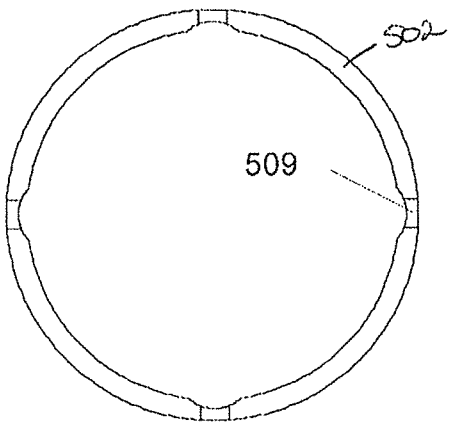

Figure 5a

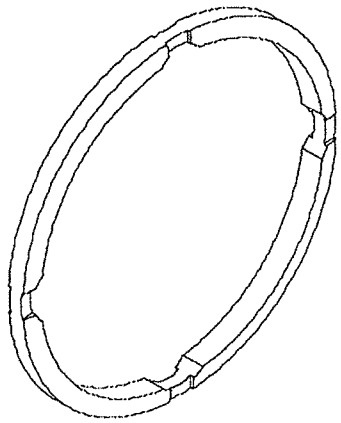

Figure 5b

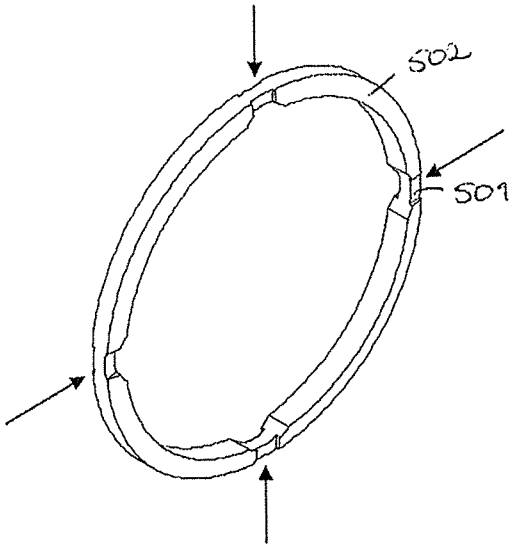

Figure 5c

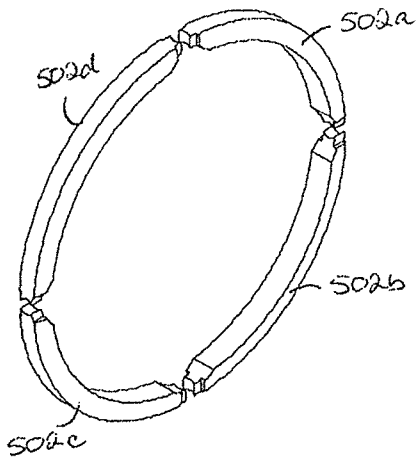

Figure 5d

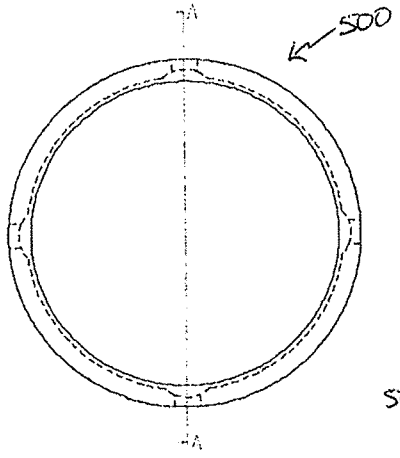

Figure 5e

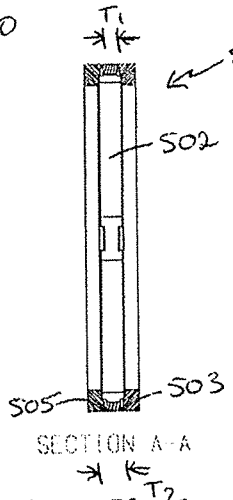

Figure 5f

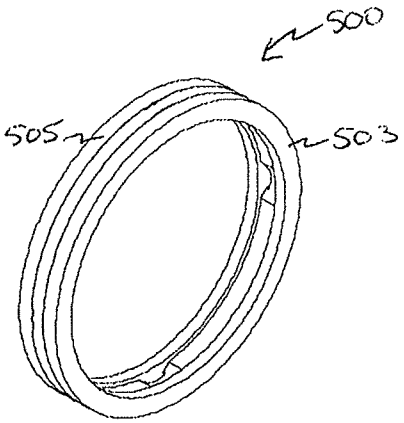

Figure 5g

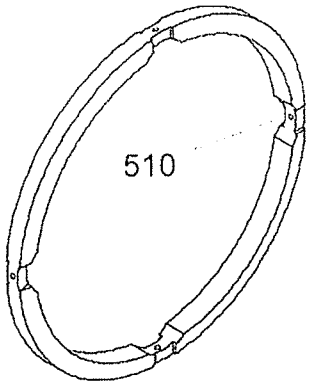

Figure 5h

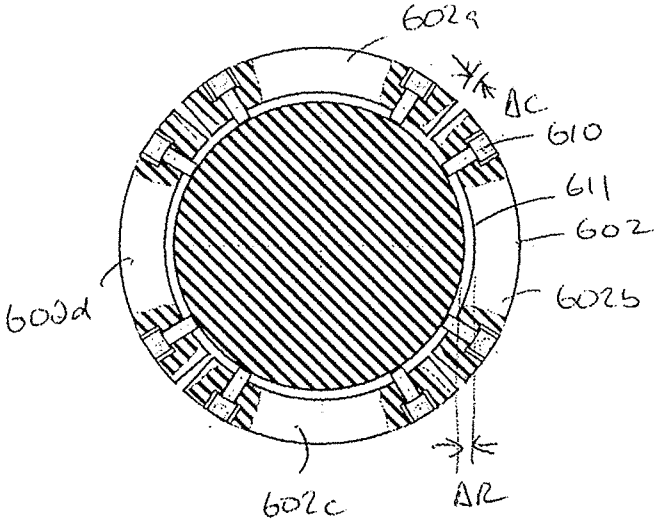

Figure 6