The present invention generally relates to an apparatus and a method for sealing a wellbore. In one aspect, a sealing apparatus for use in a wellbore is provided. The apparatus includes a compressible sealing member disposed around a body and an anchoring device. The apparatus further includes an anti-extrusion assembly having at least one flexible segment and one seal ring disposable at each end of the compressible sealing member, wherein the anti-extrusion assembly is constructed and arranged to form a barrier around the ends of the compressible sealing member upon expansion thereof. In another aspect, a downhole tool for sealing an annulus of a wellbore is provided. In yet another aspect, a method for sealing a wellbore is provided.
ANTI-EXTRUSION ASSEMBLY FOR A PACKING ELEMENT SYSTEM

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application is a continuation-in-part of co-pending U.S. patent application Ser. No. 09/733,632, entitled High Temperature And Pressure Element System, filed on Dec. 8, 2000, which patent application is herein incorporated by reference.

BACKGROUND OF THE INVENTION

[0002] 1. Field of the Invention

[0003] The present invention relates to downhole packers. More particularly, the present invention relates to a high pressure and temperature element system for a downhole packer.

[0004] 2. Description of the Related Art

[0005] Downhole packers are typically used to seal an annular area formed between two co-axially disposed tubulars within a wellbore. For example, downhole packers may seal an annulus formed between production tubing disposed within wellbore casing. Alternatively, packers may seal an annulus between the outside of a tubular and an unlined borehole. Routine uses of packers include the protection of casing from pressure, both well and stimulation pressures, as well as the protection of the wellbore casing from corrosive fluids. Other common uses include the isolation of formations or leaks within a wellbore casing or multiple producing zones, thereby preventing the migration of fluid between zones. Packers may also be used to hold kill fluids or treating fluids within the casing annulus.

[0006] Conventional packers typically comprise a sealing element located between upper and lower retaining rings or elements. The sealing element is typically a synthetic rubber composite which can be compressed by the retaining rings to expand radially outward into contact with an inner surface of a well casing there-around. This compression and expansion of the sealing element seals the annular area by preventing the flow or passage of fluid across the expanded sealing element.

[0007] Conventional packers are typically run into a wellbore within a string of tubulars and anchored in the wellbore using mechanical compression setting tools or fluid pressure devices. Conventional packers are also typically installed using cement or other materials pumped into an inflatable sealing element.

[0008] One problem associated with conventional packers arises with high temperature and/or high pressure applications. High temperatures are generally defined as downhole temperatures above 300°F and up to 450°F. High pressures are generally defined as downhole pressures above 7,500 psi and up to 15,000 psi. At these temperatures and pressures, conventional sealing elements become ineffective. Most often, the physical properties of the sealing element suffer from degradation due to the extreme conditions. For example, the sealing element may experience a loss of elasticity. Alternatively, the sealing element may melt or otherwise decrease in viscosity or flow or extrude.

[0009] Another problem associated with conventional packers occurs during the activation of the conventional packer at high temperatures and pressures. Most often, the sealing element softens and possibly flows before the packer reaches its final destination in the wellbore. Consequently, the sealing element becomes disconfigured and cannot be properly activated. As a result, the sealing element does not adequately seal the annulus.

[0010] Yet another problem associated with the packing element system of the conventional packer arises when the conventional packer is no longer needed to seal the wellbore, and must be removed from the well. For example, plugs and packers are sometimes intended to be temporary and must be removed to access the wellbore there below. Rather than de-actuate the packer and bring it to the surface of the well, the packer is typically destroyed with a rotating milling or drilling device. As the mill contacts the packer, the packer is “drilled up” or reduced to small pieces that are either washed out of the wellbore or simply left at the bottom of the hole. The more parts making up the conventional packer, the longer the milling operation takes. Longer milling time, leads to an increase in wear and tear of the drill bit and additional expensive rig time.

[0011] Furthermore, another problem associated with the packing element system of the conventional packer is the manufacturing cost. Additional parts increase the cost and complexity of the packer.

[0012] Therefore, there is a need for a downhole packer having an element system that can resist or prevent extrusion or degradation in high temperature and/or high pressure applications. There is also a need for a method for actuating a downhole packer that can withstand a high temperature and/or high pressure environment by staging the expansion of a sealing element and minimizing a void within an annulus to be sealed. Further, there is a need for a packing element system for use in a downhole packer that will minimize the time of a milling operation upon removal of the packer, and subsequently reduce the wear and tear on the drill bit. There is a further need for a packing element system with fewer components, thereby reducing the manufacturing cost.

SUMMARY OF THE INVENTION

[0013] The present invention generally relates to an apparatus and a method for sealing a wellbore. In one aspect, a sealing apparatus for use in a wellbore is provided. The apparatus includes a compressible sealing member disposed around a body and an anchoring device. The apparatus further includes an anti-extrusion assembly having at least one flexible segment and one seal ring disposable a each end of the compressible sealing member, wherein the anti-extrusion assembly is constructed and arranged to form a barrier around the ends of the compressible sealing member upon expansion thereof.

[0014] In another aspect, a downhole tool for sealing an annulus of a wellbore is provided. The downhole tool includes an anchoring and scaling system disposed about a body. The anchoring and scaling system includes a compressible sealing member and a cone and slip arrangement. The anchoring and seal system further includes an anti-extrusion assembly having at least one flexible segment and one seal ring disposable a each end of the sealing member,
wherein the anti-extrusion assembly is constructed and arranged to form a barrier around the ends of the compressible sealing member upon expansion thereof.

[0015] In another aspect, a method for sealing a wellbore is provided. The method includes running a sealing apparatus in to the wellbore. The sealing apparatus includes a compressible sealing member disposed around a body and an anti-extrusion assembly having at least one flexible segment and one seal ring disposable a each end of the sealing member, wherein the anti-extrusion assembly is constructed and arranged to form a barrier around the ends of the compressible sealing member upon expansion thereof. The method further includes applying an axial force to the sealing apparatus to cause the anchoring device to grip the wellbore and expanding the sealing member into contact with an area of the wellbore. The method also includes deforming the flexible segment and creating a barrier to prevent the sealing member from extruding under the anchoring device.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016] So that the manner in which the above recited features, advantages, and objects of the present invention are attained and can be understood in detail, a more particular description of the invention, briefly summarized above, may be had by reference to the embodiments thereof which are illustrated in the appended drawings.

[0017] It is to be noted, however, that the appended drawings illustrate only typical embodiments of this invention and are therefore not to be considered limiting of its scope, for the invention may admit to other equally effective embodiments.

[0018] FIG. 1 is a cross section of a packer of the present invention.

[0019] FIG. 1A is an enlarged view of a retaining assembly disposed about a body of the packer shown in FIG. 1.

[0020] FIG. 2 is a partial cross section of the packer during a first stage of activation.

[0021] FIG. 3 is a partial cross section of the packer during a second stage of activation.

[0022] FIG. 4 is a partial cross section of the packer during a third stage of activation.

[0023] FIG. 4A is an enlarged view of the element system disposed about the body of the packer shown in FIG. 4 during the third stage of activation.

[0024] FIG. 5A is a cross-sectional view illustrating a preferred embodiment of an anti-extrusion assembly prior to activation of a sealing apparatus.

[0025] FIG. 5B is an enlarged view of the anti-extrusion assembly.

[0026] FIG. 5C is a cross-sectional view illustrating the preferred embodiment of the anti-extrusion assembly during the initial activation stage of the sealing apparatus.

[0027] FIG. 5D is a cross-sectional view illustrating the preferred embodiment of the anti-extrusion assembly after the activation of the sealing apparatus.

[0028] FIG. 6A is an enlarged cross-sectional view illustrating an alternative embodiment of an anti-extrusion assembly with a spacer prior to activation of the sealing apparatus.

[0029] FIG. 6B is an enlarged cross-sectional view illustrating the anti-extrusion assembly with the spacer after activation of the sealing apparatus.

[0030] FIG. 7A is an enlarged cross-sectional view illustrating an alternative embodiment of an anti-extrusion assembly prior to activation of the sealing apparatus.

[0031] FIG. 7B is an enlarged cross-sectional view illustrating the anti-extrusion assembly after activation of the sealing apparatus.

[0032] FIG. 8A is an enlarged cross-sectional view illustrating an alternative embodiment of an anti-extrusion assembly prior to activation of the sealing apparatus.

[0033] FIG. 8B is an enlarged cross-sectional view illustrating the anti-extrusion assembly after activation of the sealing apparatus.

[0034] FIG. 9A is an enlarged cross-sectional view illustrating a two-piece anti-extrusion assembly prior to activation of the sealing apparatus.

[0035] FIG. 9B is an enlarged cross-sectional view illustrating the two-piece anti-extrusion assembly after activation of the sealing apparatus.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0036] FIG. 1 is a cross section of a high temperature down hole packer 100. According to one aspect of the invention, the packer 100 includes a body 102 having a first and second retaining system and an element system disposed there-around. The body 102 may include a longitudinal bore there through, and may include a sealed bore there-through. The retaining systems are disposed at either end of the element system and all are comprised of ring-shaped components concentrically disposed about the body 102. The element system comprises fill rings 320, 620, containment rings 340, 640, anti-extrusion rings 360, 660, back-up rings 380, 680, and an element 500. The first and second retaining system each comprises slips 200, 400, cones 220, 420, expansion rings 260, 460, and slide rings 300, 600. In operation, the retaining systems secure the packer 100 within a tubular therearound, such as casing for example, and provide the boundaries of an annular area for the element system to expand and seal, thereby providing an effective seal in high temperature and high pressure applications.

[0037] For ease and clarity of description, the packer 100 will be further described in more detail as if disposed within a tubular 700 in a vertical position as oriented in the figures. It is to be understood, however, that the packer 100 may be disposed in any orientation, whether vertical or horizontal. It is also to be understood that the packer 100 may be disposed in a borehole without a tubular therearound. Additionally, for ease and clarity of description, the first retaining system and an upper portion of the element system will be described since the components of the second retaining system and a lower portion of the element system are substantially identical.
[0038] Considering the retaining system in greater detail, the slip 200 is disposed about the body 102 adjacent a first end 221 of the cone 220. Each slip 200 comprises a tapered inner surface 201 conforming to the first end 221 of the cone 220. An outer surface of the slip 200, preferably includes at least one outwardly extending serration or edged tooth 205, to engage an inner surface of the tubular 700 when the slip 200 is driven radially outward from the body 102 by the movement of the sloped surfaces of the cones 220, 420 thereunder.

[0039] The slip 200 is designed to fracture with radial stress as the cones 220, 420 are driven thereunder. The slip 200 typically includes at least one recessed groove (not shown) milled therein to fracture under stress allowing the slip 200 to expand outwards to engage the inner surface of the tubular 700. For example, the slip 200 may include four evenly sloped segments separated by equally spaced recessed grooves to contact the tubular 700 and become evenly distributed about the outer surface of the body 102.

[0040] The cone 220 is disposed about the body 102 adjacent the slip 200 and is secured to the body 102 by a plurality of shearable members such as shear pins 106. As stated above, the cone 220 comprises a tapered first end 221 which rests underneath the tapered inner surface 201 of the slip 200. The slip 200 travels about the tapered first end 221 of the cone 220, thereby expanding radially outward from the body 102 to engage the inner surface of the tubular 700. Referring to FIG. 1A, the cone 220 also comprises a second end 223 which is tapered and abuts a corresponding tapered end 261 of the expansion ring 260.

[0041] Figuring to FIGS. 1 and 1A, the expansion ring 260 is disposed between the cone 220 and the slide ring 300. In the preferred embodiment, the expansion ring 260 includes a male split ring 270 and a female split ring 280. The male and female split rings 270, 280, are disposed about the body 102 so that their respective expandable openings are not vertically aligned. In this orientation, the male split ring 270 and female split ring 280 provide a solid circumferential barrier against extruded or expanded material of back-up ring 380. The male split ring 270, as depicted in section view, includes three sides. A first side 261 has a sloped surface corresponding to the sloped second end 223 of the cone 220 as described above. A second side is substantially flat or perpendicular to the body 102, with an extension 265 extending therefrom. The female split ring 280 also includes three sides, visible in section view, including a substantially flat or perpendicular first side having a recessed groove 285 disposed therein. The female split ring 280 also includes a second side having a tapered surface 283 to abut a first end of the slide ring 300. The extension 265 disposed on the second side of the male split ring 270 is disposable within the recessed groove 285. The extension 265 and recessed groove 285 allow the male and female split rings 270, 280 to engage one another thereby allowing the expansion rings 260, 460 to move radially outward from the body 102 as a single unit.

[0042] The slide ring 300 includes a first end having a first 301 and second 303 tapered surface. The first tapered surface 301 corresponds to the second tapered surface 283 of the female split ring 280. The second tapered surface 303 is sloped in an opposite direction from the first tapered surface 301 and corresponds to the sloped second end 223 of the cone 220. The slide ring 300 also includes a second end abutting the filler ring 320 and having an extension 307 disposed thereon. The extension 307 extends axially away from the slide ring 300 toward the element 500 and extends between a portion of an inner surface of the filler rings 320, 620 and an outer surface of the body 102.

[0043] Considering the element system in greater detail, the filler ring 320 comprises two sections, a larger diameter section and a smaller diameter section which form a shoulder 325 at the interface of the two sections. The smaller diameter section of the filler ring 320 is disposed about the extension 307 of slide ring 300. The larger diameter section rests against the outer surface of the body 102. The filler ring 320 may be manufactured from Teflon® or any flexible plastic or resin material which flows at a predetermined temperature. As will be explained below, the filler ring 320 will expand under high temperature and/or pressure and create a collapse load on the extension 307 of the slide ring 300. This collapse load holds the slide ring 300 firmly against the body 102.

[0044] A spacer ring 310 is disposed about the body 102 between the slide ring 300 and the filler ring 320. The spacer ring 310 serves to accommodate tolerance variations created during the manufacturing of the element system.

[0045] The back-up ring 380 is disposed about the body 102 between the element 500 and the filler ring 320. The back-up ring 380 includes a recessed groove 385 formed in a portion of an outer surface thereof. Similar to the filler ring 320 the back-up ring 380 may be manufactured from Teflon® or any flexible plastic or resin material which flows at a predetermined temperature. At high temperatures, the back-up ring 380 expands radially outward from the body 102 and flows across the outer surface of the body 102. As will be explained below, the back-up ring 380 helps to fill a void 550 created between the expansion rings 260, 460, thereby reducing a volume of the void 550 to be filled by the element 500.

[0046] The anti-extrusion ring 360 is disposed in a portion of the groove 385 and extends over the second portion of the filler ring 320. The anti-extrusion ring 360 includes a lip 365 which extends radially inward toward the body 102. The lip 365 is disposed adjacent the shoulder 325 formed between the larger diameter and the smaller diameter sections of the filler ring 320. As will be explained below, the lip 365 prevents the filler ring 320 from flowing or traveling between the anti-extrusion ring 360 and the containment ring 340. The lip 365 also acts as a carrier when the back-up ring 380 expands and travels over the slide ring 300.

[0047] The containment ring 340 is disposed about an outer surface of the smaller diameter section of the filler rings 320, 620. The containment ring 340 includes a first end which abuts the spacer ring 310 and a second end which abuts the anti-extrusion ring 360. As will be explained below, the containment ring 340 holds the filler ring 320 in place and prevents the filler ring 320 from extruding across an outer surface of the slide ring 300.

[0048] The element 500 is disposed about the body 102 between the back-up rings 380, 680. The element 500 may have any number of configurations to effectively seal the annulus created between the body 102 and the casing wall.
For example, the element 500 may include grooves, ridges, indentations, or protrusions designed to allow the element 500 to conform to variations in the shape of the interior of the tubular 700 there-around. The element 500 can be constructed of any expandable or otherwise malleable material which creates a permanent set position and stabilizes the body 102 relative to the wellbore casing. For example, the element 500 may be a metal, a plastic, an elastomer, or a combination thereof. The element 500, however, must withstand temperatures in excess of 450°F, and pressures in excess of 15,000 psi.

[0049] Referring to FIG. 4, the packer 100 further includes a ratchet assembly 800 disposed about a first end of the packer 100 to prevent the components described above from prematurely releasing once the components have been actuated. The ratchet assembly 800 includes a ring housing 810 disposed about a lock ring 830 and is disposed about the body 102 adjacent to and abutting a first end of the slip 200.

[0050] The lock ring 830 is a cylindrical member annularly disposed between the body 102 and the ring housing 810 and includes an inner surface having profiles disposed thereon to mate with profiles formed on the outer surface of the body 102. The profiles formed on the lock ring 830 have a tapered leading edge allowing the lock ring 830 to move across the mating profiles formed on the body 102 in one axial direction while preventing movement in the other direction. The profiles formed on both the outer surface of the body 102 and an inner surface of the lock ring 830 consist of formations having one side which is sloped and one side which is perpendicular to the outer surface of the body 102. The sloped surfaces of the mating profiles allows the lock ring 830 to move across the body 102 in a single axial direction. The perpendicular sides of the mating profiles prevent movement in the opposite axial direction. Therefore, the split ring may move or "ratchet" in one axial direction, but not the opposite axial direction.

[0051] The ring housing 810 comprises a jagged inner surface to engage a mating jagged outer surface of the lock ring 830. The relationship between the jagged surfaces creates a gap there-between allowing the lock ring 830 to expand radially as the profiles formed thereon move across the mating profiles formed on the body 102. A longitudinal cut within the lock ring 830 allows the lock ring 830 to expand radially and contract as it moves on planes or ratchets in relation to the outer surface of the body 102. The ring housing 810 also comprises a first end which abuts a first end of the slip 200 thereby transferring movement of the ratchet assembly 800 to the slip 200.

[0052] To set or activate the packer 100, the packer 100 is first run down the hole to a predetermined depth. A setting tool applies an axial load to the outer components of the packer 100 relative to the body 102. Once the axial force reaches a predetermined value, the pins 106 release or shear, thereby causing the outer components to move axially across the body 102.

[0053] FIG. 2 is a section view of a packer 100 during a first stage of activation. During a first stage of activation, axial movement of the outer components forces the cone 420 underneath the slip 400, thereby forcing the slip 400 radially outward toward the tubular 700. As shown in FIGS. 2 and 4A, the slip 400 engages the inner surface of the tubular 700 creating an opposing axial force which causes the expansion rings 260, 460, to slide radially outward across the surface 223 of the cones 220, 420 and across the first tapered surface 301 of the slip rings 300, 600, thereby engaging the inner surface of the slip rings 300, 600. The actuation of the expansion rings 260, 460, provide a fixed volume or void space 550 within the annulus to be sealed off by the element 500 and back-up rings 380, 680 and also provide an extrusion barrier on the face of the cones 220, 420, and the inner surface of the tubular 700.

[0054] The axial forces next cause the recessed grooves of the slip 400 to fracture, and divide into equal segments, permitting the serrations or teeth 405 to engage the inner surface of the tubular 700. Once the slip 400 fractures, the axial forces across the body 102 are met by an equal and opposite axial force which causes the malleable outer portions of the packer 100 to compress and expand radially outward.

[0055] FIG. 3 shows a second stage of activation which involves extruding the back-up rings 380, 680. As shown, the compressive forces exerted against opposite sides of the back-up rings 380, 680 cause the back-up rings 380, 680, to expand radially outward toward the tubular 700. Expansion of the back-up rings 380, 680, causes the anti-extrusion rings 360, 660, to expand due to the applied hoop stress created by the expanding back-up rings 380, 680. As the anti-extrusion rings 360, 660, yield, the back-up rings 380, 680, are allowed to travel or flow up and over the filler rings 320, 620, the containment rings 340, 460, and the slide rings 300, 600, as shown in FIG. 4. The increasing pressure exerted by the back-up rings 380, 680, and the element 500 applies a load to the filler rings 320, 620, that applies a collapse load on the extension 307 of the slide rings 300, 600, thereby eliminating any extrusion between the slide rings 300, 600, and the body 102. The lip 365 formed on the first end of the anti-extrusion rings 360, 660, prevents the filler rings 320, 620, from flowing or traveling between the anti-extrusion rings 360, 660, and the containment rings 340, 460. The lip 365 also acts as a carrier when the back-up rings 380, 680, expands and travels over the slide rings 300, 600. The anti-extrusion rings 360, 660, also serve to retain the back-up rings 380, 680, until the expansion rings 260, 460, are fully expanded against the tubular 700.

[0056] FIG. 4 shows a third stage of activation. During a third stage of activation, the back-up rings 380, 680 flow and fill a substantial portion of the void 550 created by the expansion rings 260, 460, while the element 500 is expanded radially outward toward the tubular 700 to seal off the remaining portion of the void 550. Because the back-up rings 380, 680, occupy a significant portion of the void 550, the element 500 must only expand radially outward, not axially, to fill the remaining void 550. As a result, less stress is placed on the element 500, and the element 500 is less subject to degradation providing a more effective seal for a longer period of time.

[0057] During the final stages of activation, the axial forces cause the ratchet assembly 800 to move or ratchet down the outer surface of the body 102. As described herein, the ratcheting is accomplished when the axial forces against the lock ring 830 cause the profiles formed on the ring 830 to ramp up and over the mating profiles formed on the outer surface of the body 102. Once the profiles of the ring 830 travel up and over the adjoining profiles of the body 102, the
first lock ring 830 contracts or snaps back into place, re-setting or interlocking the concentric profiles of the lock ring 830 against the next adjoining profiles formed on the outer surface of the body 102. In this manner, the ratchet assembly 900 moves in a first direction and not in a second, opposite direction.

[0058] In another aspect, the present invention includes a packing element system for use in a sealing apparatus. Generally, the sealing apparatus is placed within the wellbore to isolate the upper and lower zones of the wellbore. Additionally, the sealing apparatus may be used to create a pressure seal in the wellbore in order to treat the isolated formation with pressurized fluids or solids. As illustrated, the sealing apparatus is a packer. It is to be understood, however, that the sealing apparatus could be a bridge plug or a frac-plug or any other device used to seal off a wellbore.

[0059] FIG. 5A is a cross-sectional view illustrating a preferred embodiment of an anti-extrusion assembly 900 prior to activation of a sealing apparatus 750. In this embodiment, the anti-extrusion assembly 900 comprises of a thin flexible segment 905 machined as part of a conventional seal ring 910. Preferably, the thin flexible segment 905 is constructed from a highly elastic material that is capable of forming to the contour of a defined area, thereby bridging any gaps that may occur during activation of the sealing apparatus 750.

[0060] FIG. 5B is an enlarged view of the anti-extrusion assembly 900. As shown, the segment 905 is formed on the lower portion of the conventional seal ring 910. This arrangement allows the segment 905 to follow the contour of a sealing element 710. Preferably, the anti-extrusion assembly 900 is fabricated from a material with mechanical properties that will withstand high temperatures and pressures while remaining ductile in order to be milled or drilled through quickly.

[0061] Referring back to FIG. 5A, the primary purpose of the conventional seal ring 910 is to hold the sealing element 710 on a mandrel 715 of the sealing apparatus 750. As illustrated, the anti-extrusion assembly 900 is disposed on both the upper and lower ends of the sealing element 710. In this respect, the anti-extrusion assembly 900 of this embodiment serves two functions. The first function is to aid in securing the element 710 to the mandrel 715, and the second function is to provide a solid barrier to the lower portion of the element 710 upon the activation of the sealing apparatus 750. To facilitate the formation of the barrier, the mating surface to the anti-extrusion assembly 900 includes a machined smooth surface and covered with a slick coating.

[0062] Adjacent the anti-extrusion assembly 900 is a plurality of split rings 725. Similar to the split rings described in a previous paragraph, the split rings 725 include a male split ring and a female split ring. Preferably, the male and female split rings are disposed about the mandrel 715 so that their respective expandable openings are not vertically aligned. In this orientation, the male split ring and female split ring provide a solid circumferential barrier for the anti-extrusion assembly 900 prior to activation of the sealing apparatus 750.

[0063] As illustrated, cones 720, 770 are disposed adjacent each split ring 725 and secured to the mandrel 715 by a plurality of shearable members 735. The cones 720, 770 include a first tapered end that abuts to a corresponding tapered end of the split rings 725. The cones 720, 770 further include a second tapered end which rests underneath a tapered inner surface of a plurality of slips 740, 760.

[0064] Preferably, the slips 740, 760 are disposed about the mandrel 715 adjacent the cones 720, 770. Each of the slips 740, 760 include at least one outwardly extending serration or edged tooth to engage an inner surface of a surrounding casing 730 as the slips 740, 760 are driven radially outward as they ride up the second tapered end of the cones 720, 770. As previously described, the slips 740, 760 are designed to radially fracture as the cones 720, 770 are driven theretofore to ensure an effective engagement with the casing 730.

[0065] FIG. 5C is a cross-sectional view illustrating the preferred embodiment of the anti-extrusion assembly 900 during the initial activation stage of the sealing apparatus 750. As similarly discussed in FIG. 2, the axial movement of the outer components apply an axial force on the cones 720, 770. At a predetermined force, the shear members 735 fail permitting the cones 720, 770 to move axially. Simultaneously, the cone 770 is forced underneath the slip 760, thereby forcing the slip 760 radially outward towards the casing 730. As the slip 760 engages the inner surface of the casing 730, an opposing axial force is created which causes the split rings 725 to move radially outward across the first tapered end of the cones 720, 770 and across a tapered end of the anti-extrusion assembly 900, thereby engaging the inner surface of the casing 730. The actuation of the split rings 725 provide an upper extrusion barrier for the element 710.

[0066] FIG. 5D is a cross-sectional view illustrating the preferred embodiment of the anti-extrusion assembly 900 after the activation of the sealing apparatus 750. As similarly discussed in FIG. 4, the element 710 is expanded radially outward towards the casing 730 to create a sealing relationship between the sealing apparatus 750 and the casing 730 and to fill the void created between the split rings 725. At the same time, the element 710 forces the anti-extrusion assembly 900 against the split rings 725 and the cones 720, 770 causing the segment 905 to form into the profile of the cones 720, 770 resulting in the formation of a solid barrier to prevent the element 710 from extruding under the split rings 725 and the cones 720, 770. In this respect, the upper portion of the element 710 is contained by the plurality of split rings 725 while the lower portion of the element 710 is contained by the flexible segment 905 of the anti-extrusion assembly 900, thereby protecting the element 710 from degradation and containing the element 710 in a defined area.

[0067] FIG. 6A is an enlarged cross-sectional view illustrating an alternative embodiment of an anti-extrusion assembly 915 with a spacer 920 prior to activation of the sealing apparatus 750. Similar to the previous embodiment, the anti-extrusion assembly 915 is disposed adjacent each side of the element 710. The anti-extrusion assembly 915 includes the conventional seal ring 910 and the flexible segment 905. Additionally, the anti-extrusion assembly 915 includes the spacer 920 disposed at the lower end of the flexible segment 905. The spacer 920 is typically fabricated from a metallic material to provide a rigid barrier at the lower end of the segment 905. However, the spacer 920 may be fabricated from other types of material so long as the
material has the capability to provide a rigid base for the flexible segment 905. As illustrated in this embodiment, the spacer 920 is oriented in a manner to provide the greatest amount of surface area for the contact with the cones 720, 770 upon actuation of the sealing apparatus 750. It is to be understood, however, that the spacer 920 may be disposed below the flexible segment 905 in any orientation, such as in front of the flexible segment 905 or behind the flexible segment 905 to provide an effective barrier to the lower portion of the element 710.

[0068] FIG. 6B is an enlarged cross-sectional view illustrating the anti-extrusion assembly 915 with the spacer 920 after activation of the sealing apparatus 750. In a similar manner as previously described, the activation of the sealing apparatus 750 moves the cones 720, 770 axially, thereby causing the split rings 725 to move radially outward from an upper barrier for the element 710. Subsequently, the element 710 is expanded radially outward toward the casing 730 to create a sealing relationship between the sealing apparatus 750 and the casing 730, and to fill the void created between the split rings 725. At the same time, the element 710 forces the anti-extrusion assembly 915 and the spacer 920 against the split rings 725 and the cones 720, 770 causing the segment 905 to form into the profile of the cones 720, 770. The formation of the segment 905 and the movement of the spacer 920 results in the creation of a solid barrier to prevent the element 710 from extruding under the split rings 725 and the cones 720, 770.

[0069] FIG. 7A is an enlarged cross-sectional view illustrating an alternative embodiment of an anti-extrusion 925 device prior to activation of the sealing apparatus 750. Similar to the previous embodiment, the anti-extrusion assembly 925 is disposed adjacent each side of the element 710 and includes the conventional seal ring 910 and the flexible segment 905. As shown in this embodiment, the flexible segment 905 follows the contour of the split rings 725 prior to the activation of the sealing apparatus 750. This arrangement permits the flexible segment 905 to be molded upon activation of the sealing apparatus 750 to create an effective barrier for the element 710.

[0070] FIG. 7B is an enlarged cross-sectional view illustrating the anti-extrusion 925 device after activation of the sealing apparatus 750. In a similar manner as previously described, the axial force applied to the sealing apparatus 750 causes the cones 720, 770 to move axially, thereby urging the split rings 725 radially outward to seal from an upper barrier for the element 710. Upon radial movement of the split rings 725, the lower portion of the flexible segment 905 previously contoured to the split rings 725 becomes exposed. Subsequently, the element 710 is expanded radially outward toward the casing 730 to create a sealing relationship between the sealing apparatus 750 and the casing 730, and to fill the void created between the split rings 725. At the same time, the element 710 forces the anti-extrusion assembly 925 against the split rings 725 and the cones 720, 770 causing the segment 905 to form into the profile of the cones 720, 770 resulting in the formation of a solid barrier to prevent the element 710 from extruding under the split rings 725 and the cones 720, 770.

[0071] FIG. 8A is an enlarged cross-sectional view illustrating an alternative embodiment of an anti-extrusion assembly 930 prior to activation of the sealing apparatus 750. Similar to a previous embodiment, the anti-extrusion assembly 925 is disposed adjacent each side of the element 710 and includes the conventional seal ring 910 and the flexible segment 905. As shown in this embodiment, the flexible segment 905 is constructed and arranged to follow the contour of the conventional seal ring 910 and the split rings 725 prior to the activation of the sealing apparatus 750. In this arrangement, the flexible segment 905 may be deformed upon the activation of the sealing apparatus 750 to create an effective barrier for the element 710.

[0072] FIG. 8B is an enlarged cross-sectional view illustrating the anti-extrusion assembly 930 after activation of the sealing apparatus 750. In a similar manner as previously described, the axial force on the sealing apparatus 750 causes the cones 720, 770 to move axially, thereby causing the split rings 725 to move radially outward to contact with the surrounding casing 730. Upon radial outward movement of the split rings 725, the lower portion of the flexible segment 905 previously contoured to the split ring 725 becomes exposed. Subsequently, the element 710 is expanded radially outward towards the casing 730 to create a sealing relationship between the sealing apparatus 750 and the casing 730, and to fill the void created between the split rings 725. At the same time, the element 710 forces the anti-extrusion assembly 930 against the split rings 725 and the cones 720, 770 causing the segment 905 to form into the profile of the cones 720, 770. This formation of the segment 905 results in the creation of a solid barrier to prevent the element 710 from extruding under the split rings 725 and the cones 720, 770. Therefore, the element 710 is defined within a predetermined area with a seal barrier on the upper portion of the element 710 created by the split rings 725 and the seal barrier on the lower portion of the element 710 created by the flexible segment 905.

[0073] FIG. 9A is an enlarged cross-sectional view illustrating a two-piece anti-extrusion assembly 935 prior to activation of the sealing apparatus 750. In a similar manner to the previous embodiment, the anti-extrusion assembly 935 is disposed adjacent each side of the element 710. The anti-extrusion assembly 935 includes a ring 940 to hold the sealing element 710 to the mandrel 715. The anti-extrusion assembly 935 further includes an end segment 945 disposed adjacent the ring 940 but not rigidly attached to the ring 940. As shown in this embodiment, the end segment 945 is constructed and arranged to form a partial enclosure around the ring 940 and the element 710 prior to activation of the sealing apparatus 750. Preferably, the end segment 945 is constructed from a high elastic material capable of forming to the contour of a defined area.

[0074] FIG. 9B is an enlarged cross-sectional view illustrating the two-piece anti-extrusion assembly 935 after activation of the sealing apparatus 750. In a similar manner as previously described, the axial force applied to the sealing apparatus 750 causes the cones 720, 770 to move axially, thereby urging the split rings 725 to move radially outward. Thereafter, the element 710 is compressed and urged radially outward to form a seal with the surrounding casing 730. At the same time, the element 710 forces the end segment 945 against the split rings 725 and the cones 720, 770 causing the end segment 945 to form into the profile of the split rings 725 and the cones 720, 770 resulting in the formation of a solid barrier to prevent the element 710 from extruding under the split rings 725 and the cones 720, 770.
While foregoing is directed to the preferred embodiment of the present invention, other and further embodiments of the invention may be devised without departing from the basic scope thereof, and the scope thereof is determined by the claims that follow.

1. A sealing apparatus for use in a wellbore, comprising:
   a body;
   a compressible sealing member disposed around the body;
   an anti-extrusion assembly having at least one flexible segment and one seal ring disposed at each end of the compressible sealing member, wherein the anti-extrusion assembly is constructed and arranged to form a barrier around the ends of the compressible sealing member upon expansion thereof; and
   an anchoring device.

2. The apparatus of claim 1, wherein the flexible segment is fabricated from a highly elastic material capable of forming to a contour of a defined area.

3. The apparatus of claim 1, wherein the seal ring secures the compressible sealing member to the body.

4. The apparatus of claim 1, wherein the flexible segment is fabricated as part of the seal ring.

5. The apparatus of claim 1, further including a plurality of split rings disposed adjacent the anti-extrusion assembly.

6. The apparatus of claim 5, wherein the anchoring device consists of a plurality of cones and slips.

7. The apparatus of claim 6, wherein the anti-extrusion assembly is formed into the profile of the plurality of cones and the plurality of split rings upon expansion of the compressible sealing member.

8. The apparatus of claim 1, wherein the anti-extrusion assembly forms the barrier around a lower portion of the compressible sealing member to prevent the compressible sealing member from extruding under the anchoring device.

9. The apparatus of claim 1, wherein the mating surface of the anti-extrusion assembly includes a smooth machined surface and a slick coating.

10. The apparatus of claim 1, further including a spacer disposed at the lower end of the flexible segment.

11. The apparatus of claim 1, wherein the flexible segment is disposed adjacent the seal ring.

12. A downhole tool for sealing an annulus of a wellbore, comprising:
   a body; and
   an anchoring and sealing system disposed about the body, wherein the anchoring and sealing system comprises:
   a compressible sealing member;
   an anti-extrusion assembly having at least one flexible segment and one seal ring disposed at each end of the compressible sealing member, wherein the anti-extrusion assembly is constructed and arranged to form a barrier around the ends of the compressible sealing member upon expansion thereof;
   a cone and slip arrangement; and
   a plurality of split rings disposed adjacent the anti-extrusion assembly.

13. The downhole tool of claim 12, wherein the flexible segment is fabricated from a highly elastic material capable of forming to a contour of a defined area.

14. The downhole tool of claim 12, wherein the flexible segment forms the barrier around the lower portion of the compressible sealing member.

15. The downhole tool of claim 12, wherein the flexible segment is fabricated as part of the seal ring.

16. A method for sealing a wellbore, comprising:
   running a sealing apparatus into the wellbore, the sealing apparatus comprising:
   a body;
   a compressible sealing member disposed around the body;
   an anti-extrusion assembly having at least one flexible segment and one seal ring disposed at each end of the compressible sealing member, wherein the anti-extrusion assembly is constructed and arranged to form a barrier around the ends of the compressible sealing member upon expansion thereof; and
   an anchoring device;
   applying an axial force to the sealing apparatus to cause the anchoring device to grip the wellbore;
   expanding the sealing member into contact with an area of the wellbore; and
   deforming the flexible segment and creating a barrier to prevent the sealing member from extruding under the anchoring device.

17. The method of claim 16, wherein the flexible segment is fabricated from a highly elastic material capable of forming to a contour of a defined area.

18. The method of claim 16, wherein the anchoring device consists of a cone and slip arrangement.

19. The method of claim 16, further including bridging any gaps between the sealing member and the anchoring device due to activation of the sealing apparatus.

20. The method of claim 16, wherein the sealing apparatus further includes a plurality of split rings disposed adjacent the anti-extrusion assembly.

21. The method of claim 20, further including containing the sealing member within a predefined space by the anti-extrusion assembly and the plurality of split rings.

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