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(54) [NANOTUBE ELECTRON EMISSION THERMAL ENERGY TRANSFER DEVICES]

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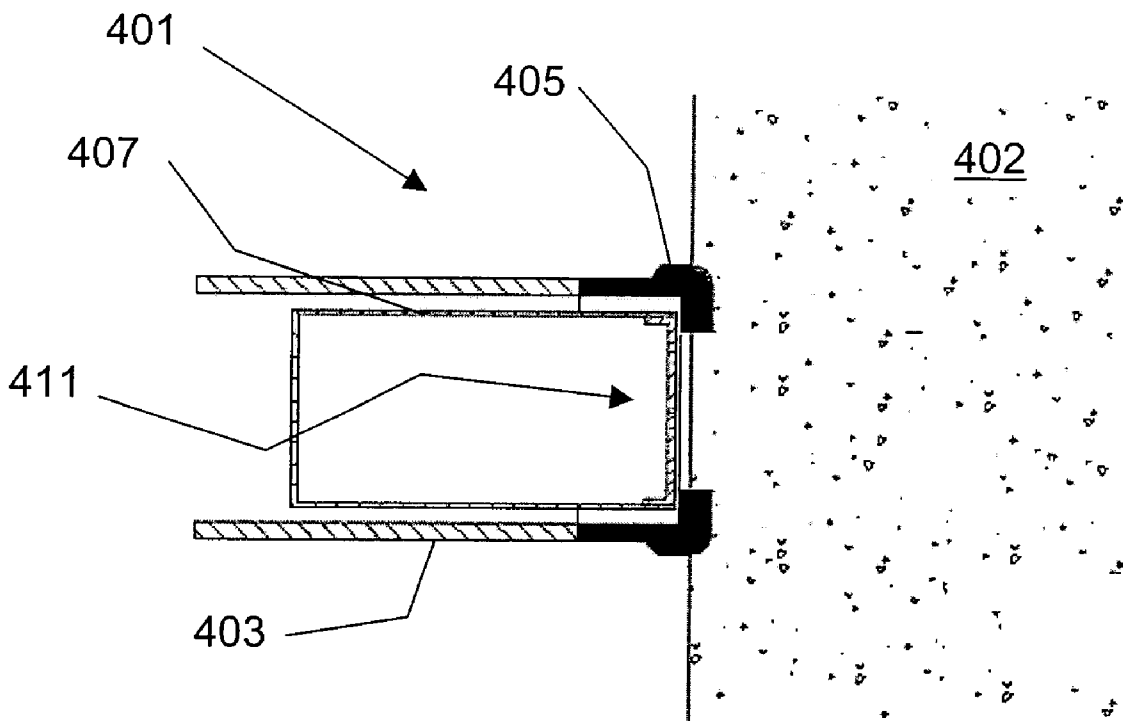
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(57) **ABSTRACT**

In some embodiments, the invention relates to a sidewall coring tool that includes a tool body, a hollow coring shaft extendable from the tool body, and a formation cutter disposed at a distal end of the hollow coring shaft. The coring tool includes a retention member segmented into a plurality of petals and disposed proximate a distal end of the internal shaft. An internal sleeve may be disposed inside the hollow coring shaft.

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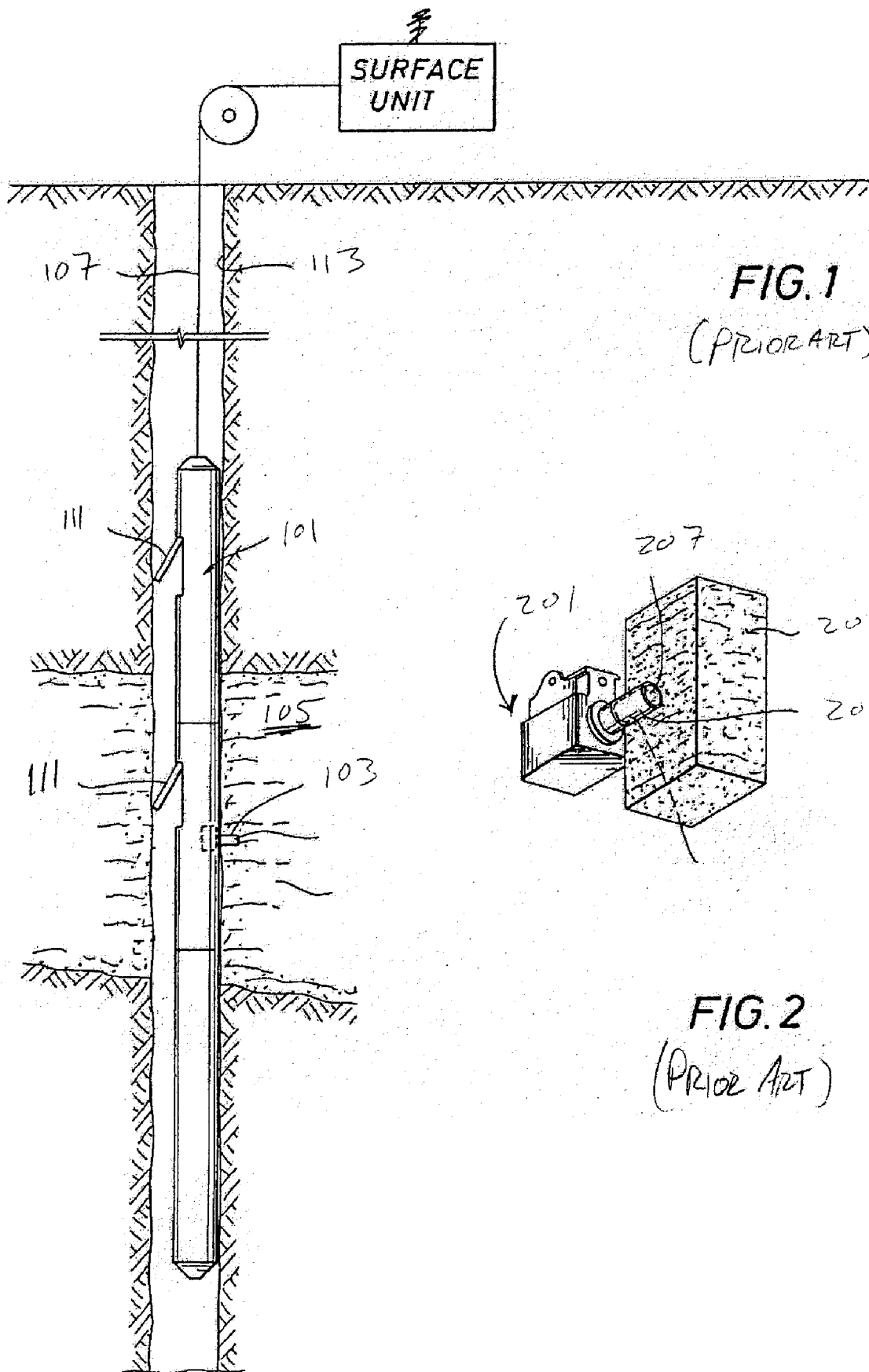


FIG. 1
(PRIOR ART)

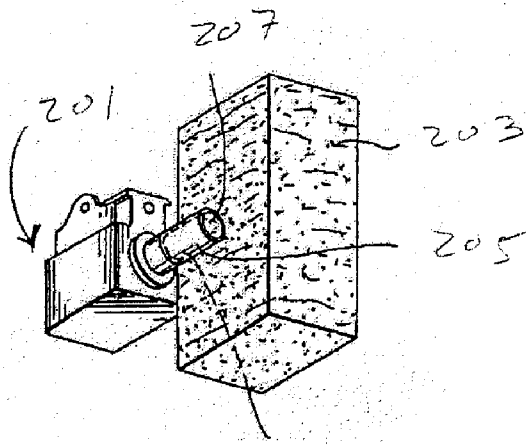


FIG. 2
(PRIOR ART)

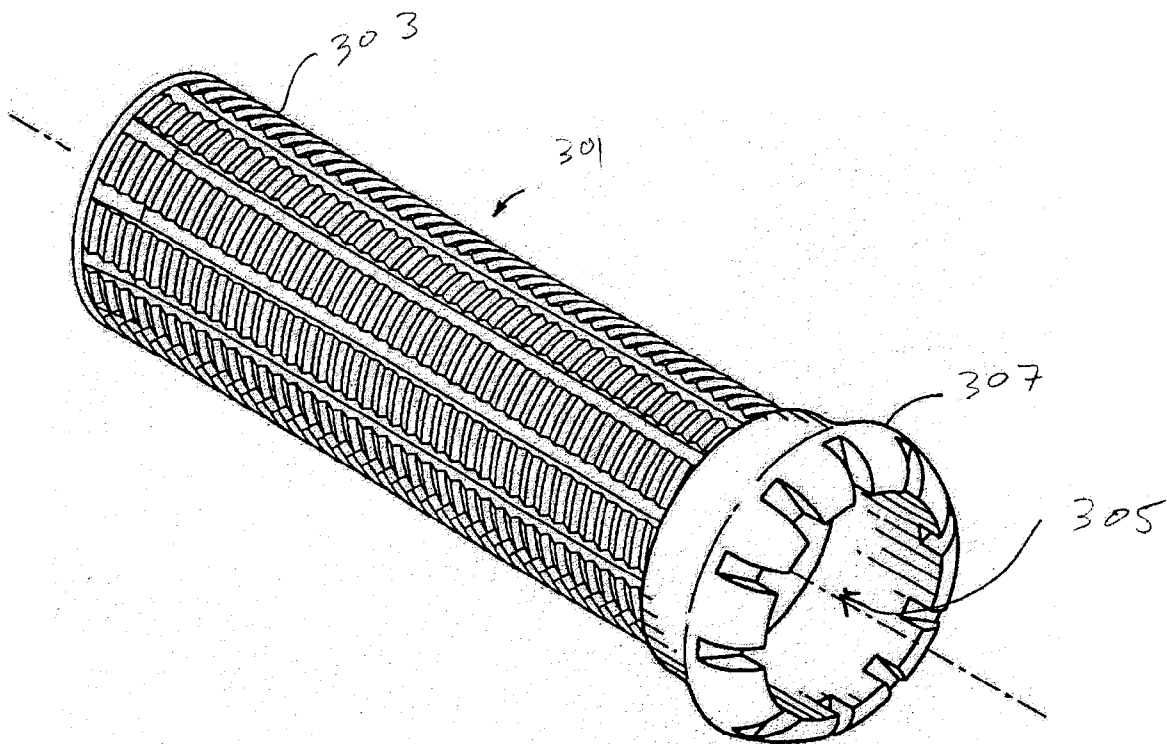
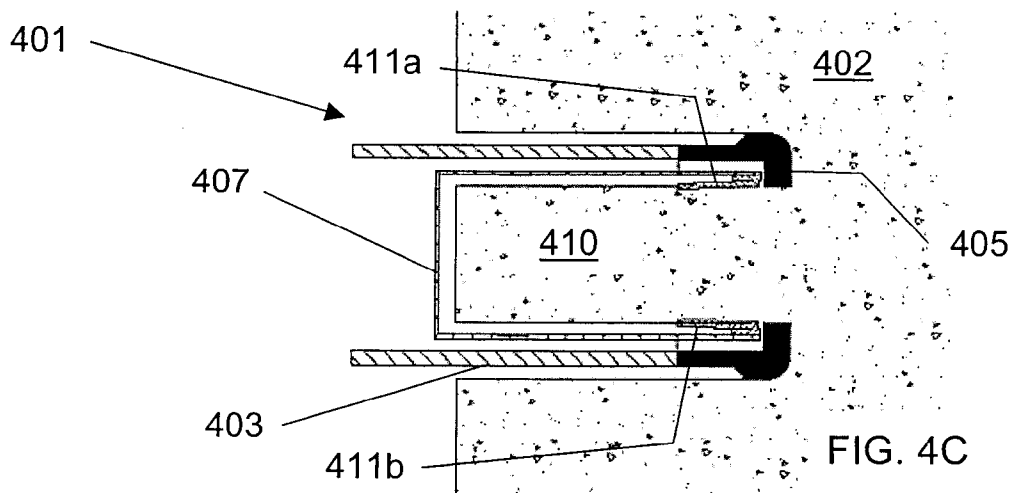
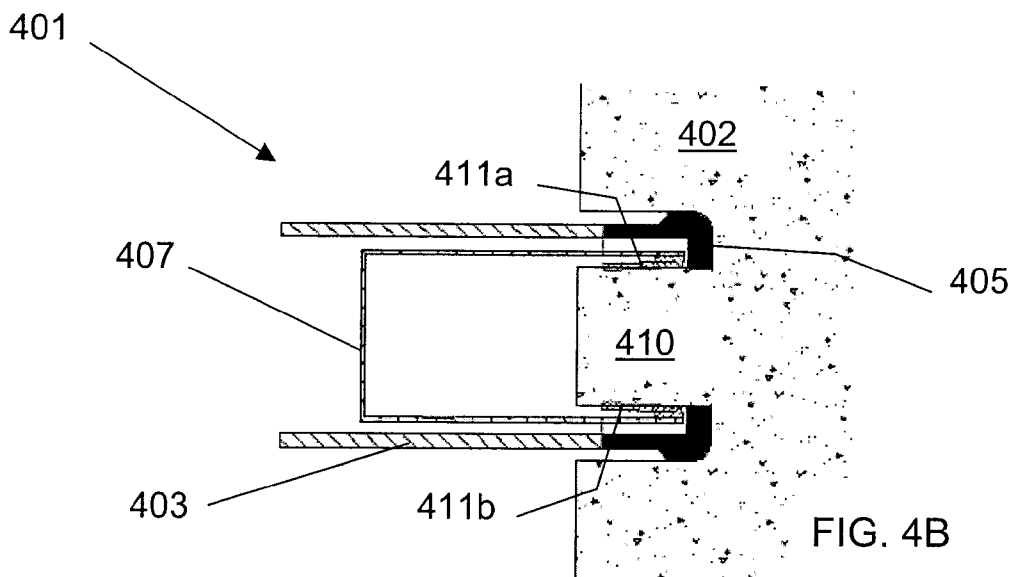
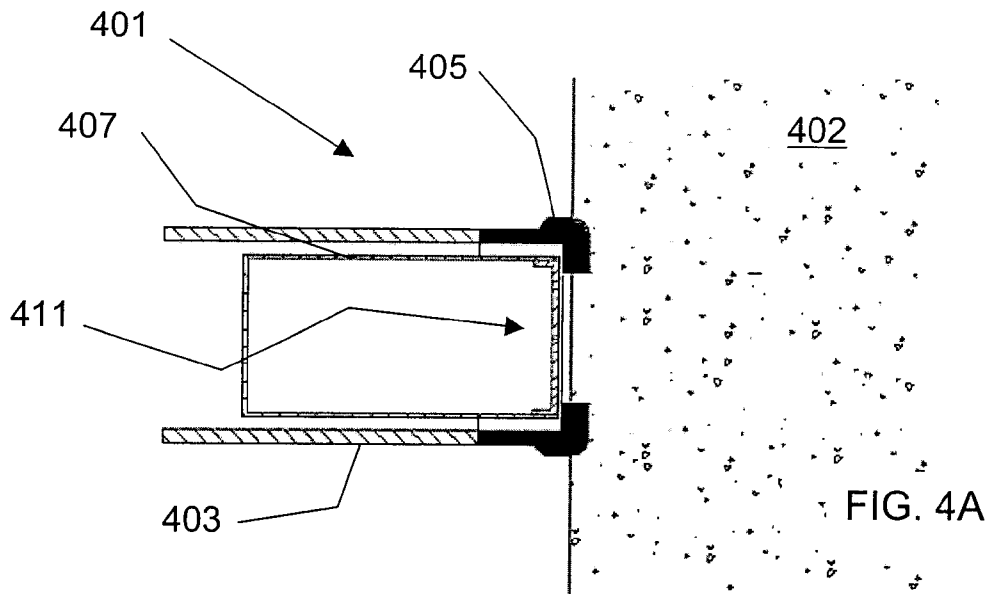


FIG. 3
(Prior Art)



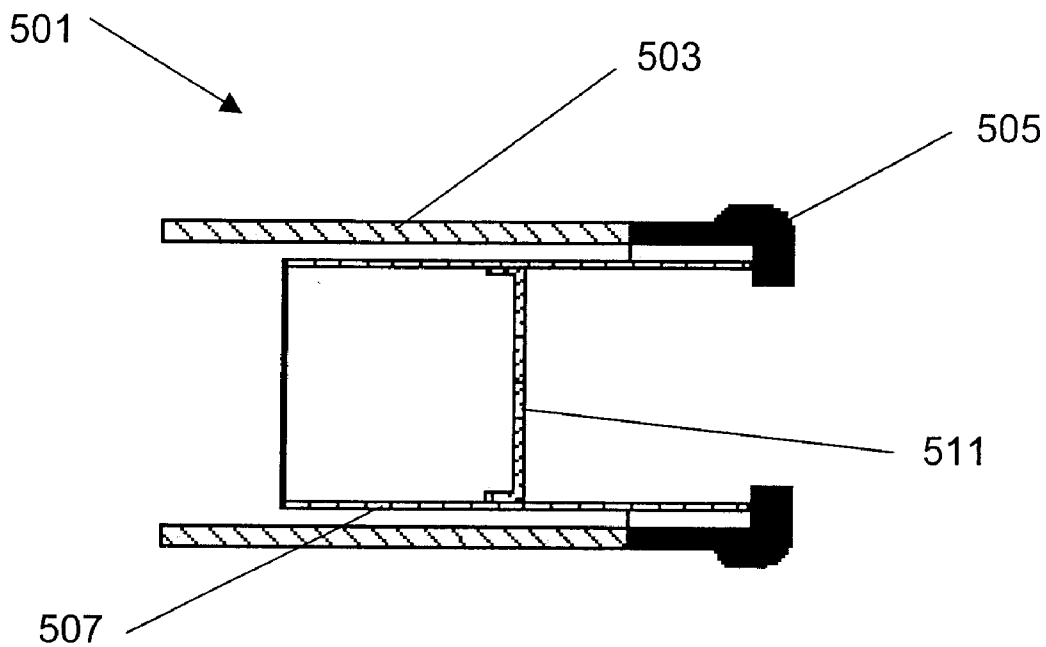


FIG. 5A

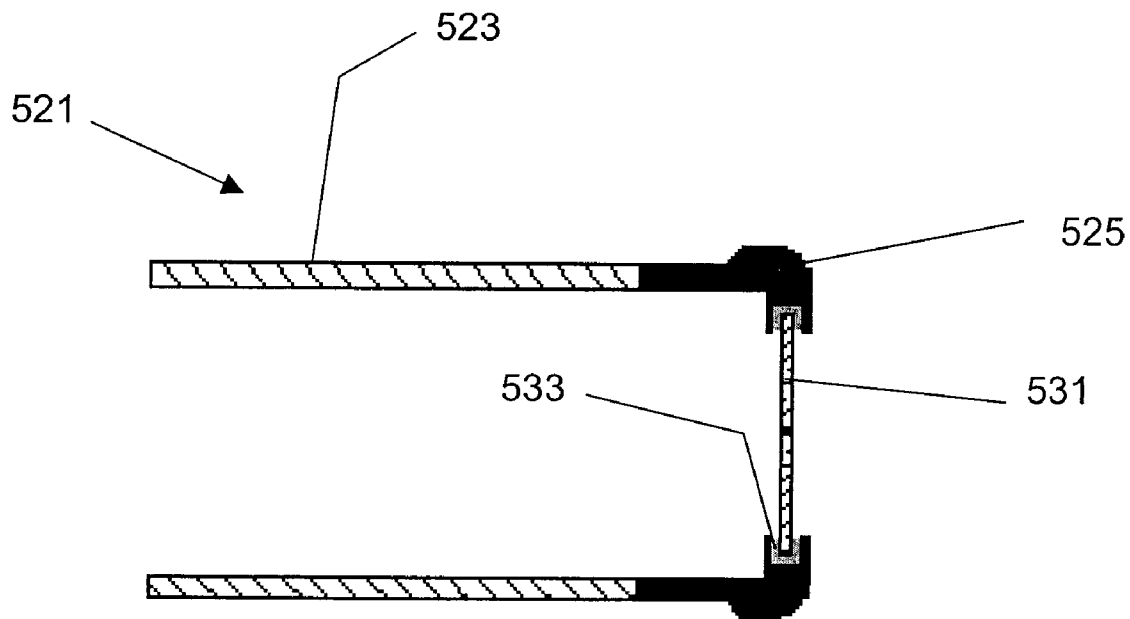


FIG. 5B

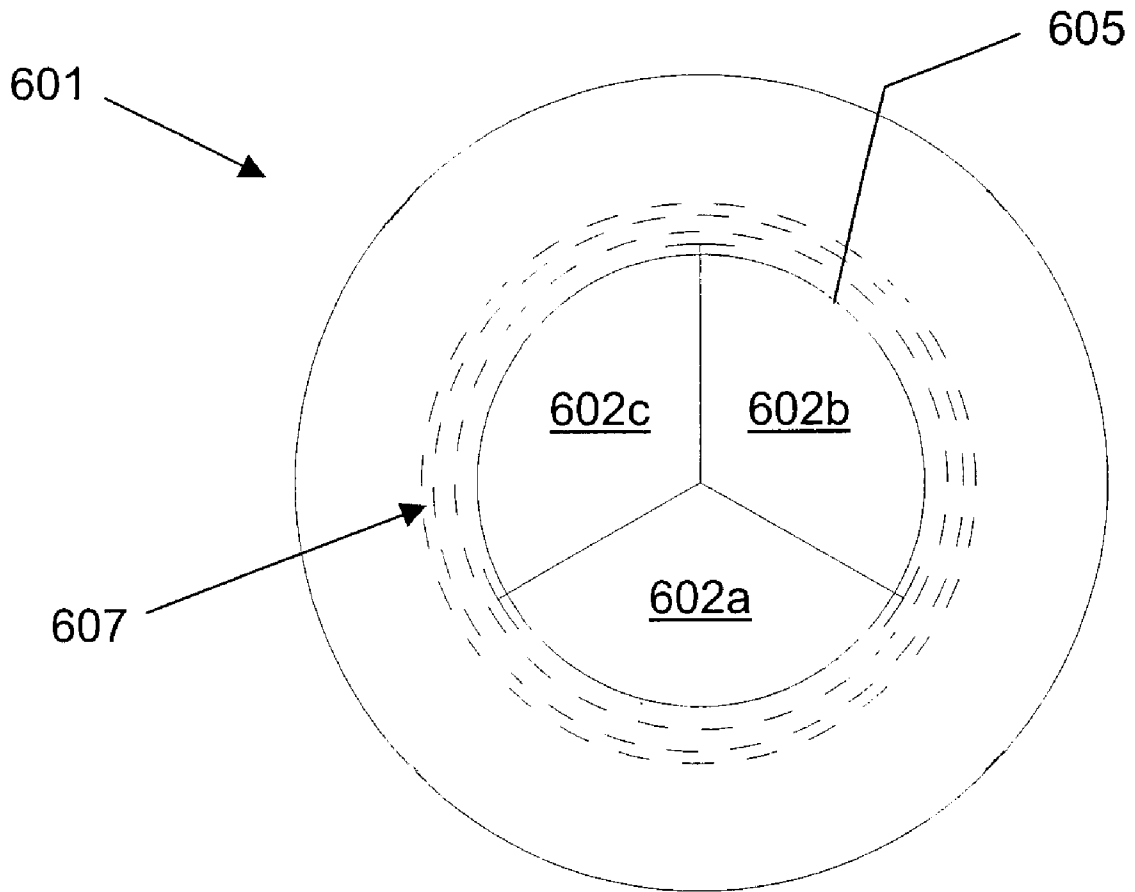


FIG. 6a

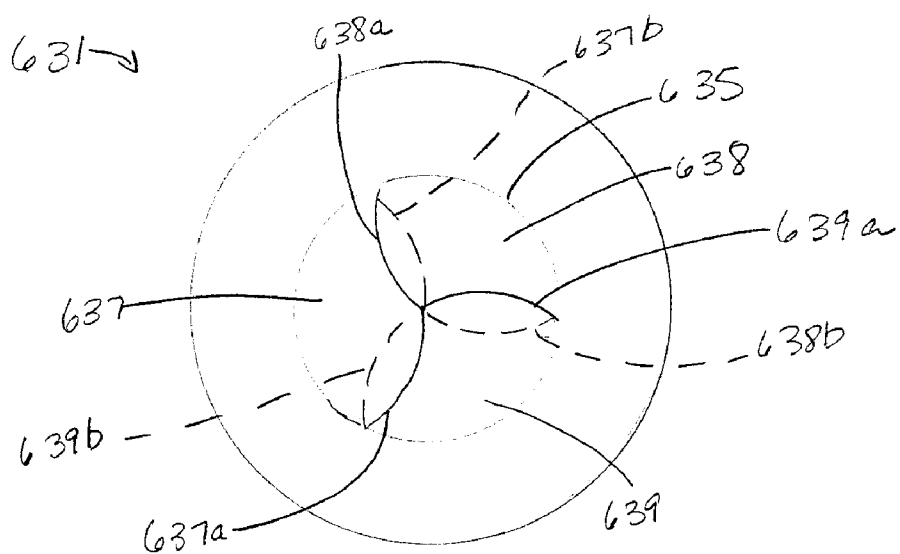


FIG. 6C

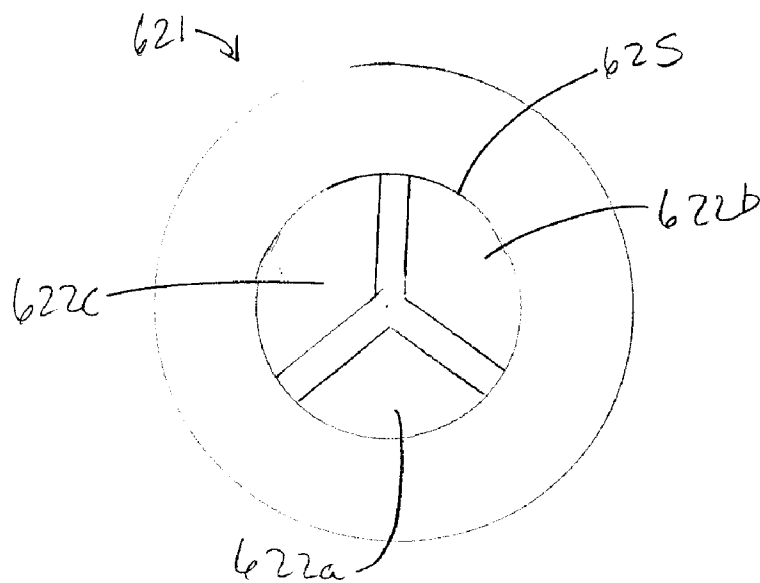


FIG. 6B

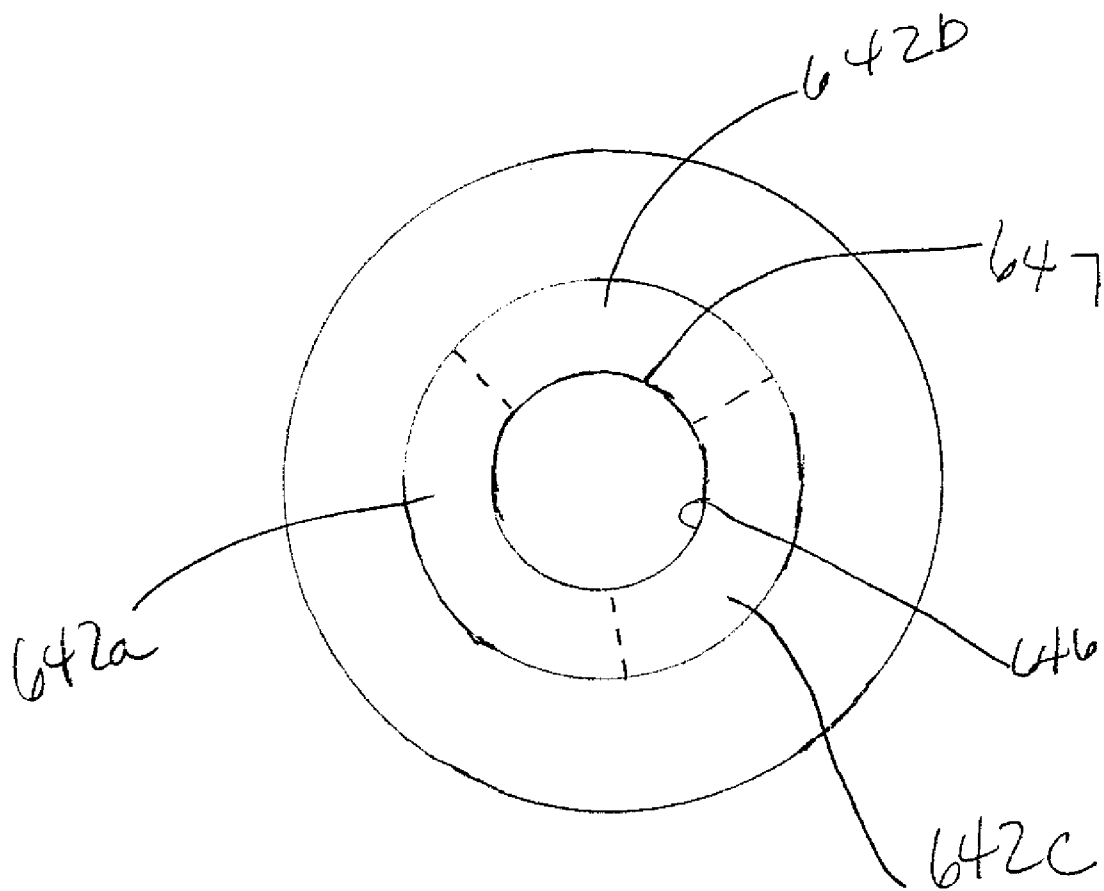


FIGURE 6D

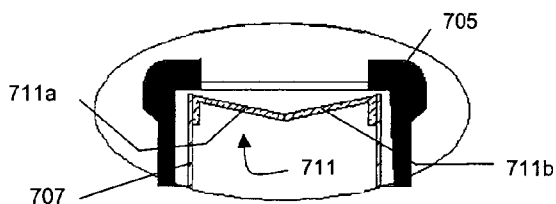


FIG. 7A

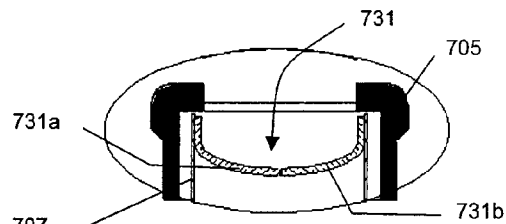


FIG. 7C

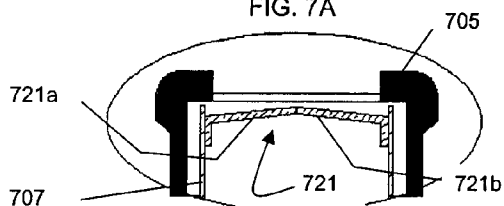


FIG. 7B

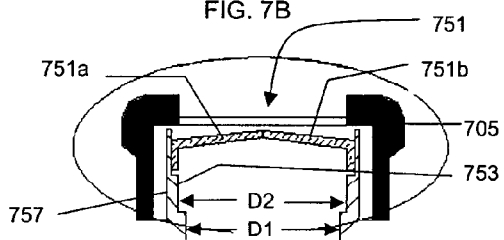


FIG. 7E

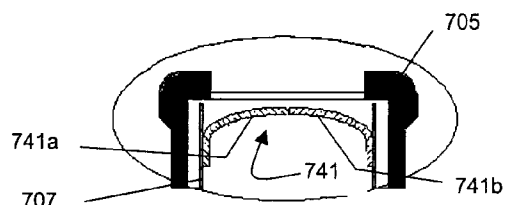
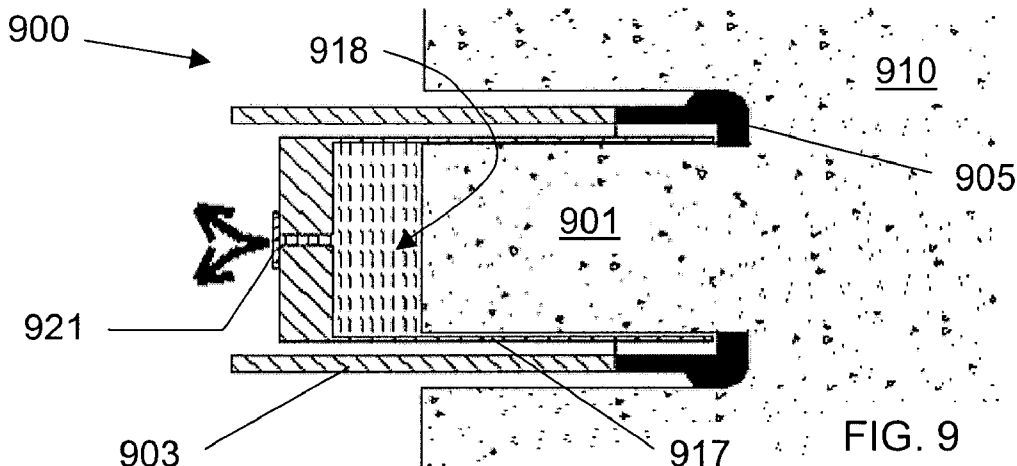
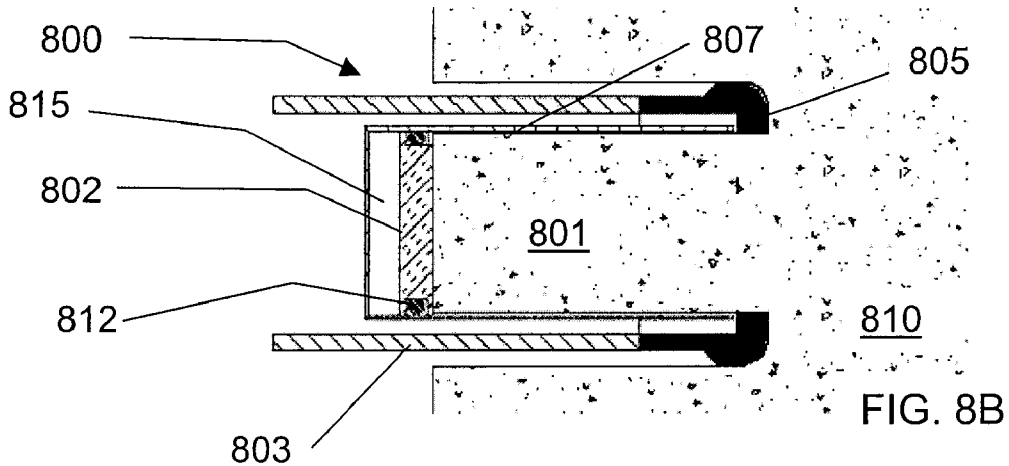
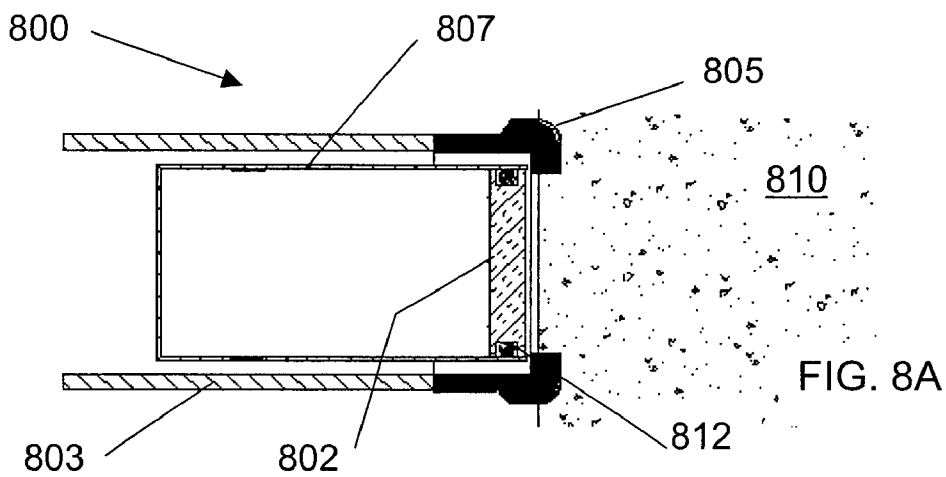


FIG. 7D



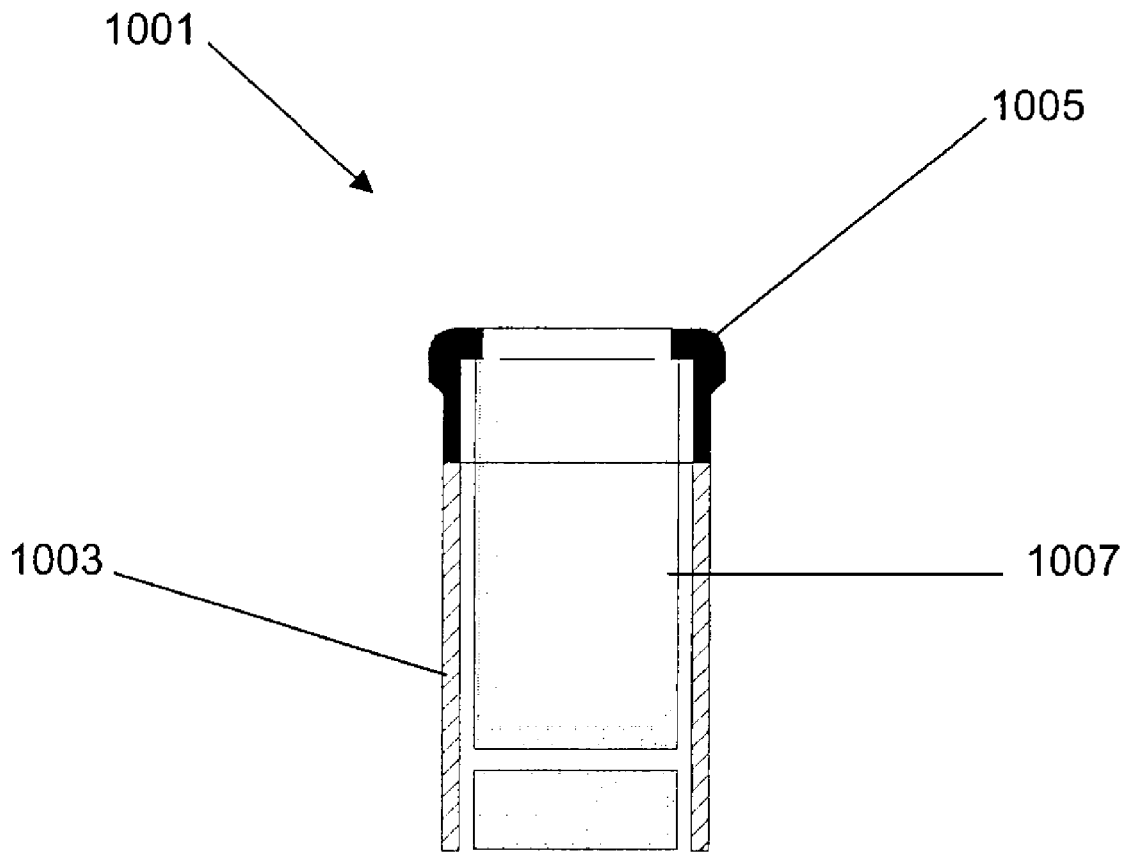


FIG. 10

[NANOTUBE ELECTRON EMISSION THERMAL
ENERGY TRANSFER DEVICES]

BACKGROUND OF INVENTION

[0001] Wells are generally drilled into the ground to recover natural deposits of oil and gas, as well as other desirable materials, that are trapped in geological formations in the Earth's crust. A well is drilled into the ground and directed to the targeted geological location from a drilling rig at the Earth's surface.

[0002] Once a formation of interest is reached, drillers often investigate the formation and its contents by taking samples of the formation rock and analyzing the rock samples. Typically, a sample is cored from the formation using a hollow coring bit, and the sample obtained using this method is generally referred to as a "core sample." Once the core sample has been transported to the surface, it may be analyzed to assess, among other things, the reservoir storage capacity (porosity) and the flow potential (permeability) of the material that makes up the formation; the chemical and mineral composition of the fluids and mineral deposits contained in the pores of the formation; and the irreducible water content of the formation material. The information obtained from analysis of a sample is used to design and implement well completion and production facilities.

[0003] "Conventional coring," or axial coring, involves taking a core sample from the bottom of the well. Typically, this is done after the drill string has been removed, or "tripped," from the wellbore, and a rotary coring bit with a hollow interior for receiving the core sample is lowered into the well on the end of a drill string. Some drill bits include a coring bit near the center of the drill bit, and a core sample may be taken without having to trip the drill string. A core sample obtained in conventional coring is taken along the path of the wellbore; that is, the core is taken along the axis of the borehole from the rock below the drill bit.

[0004] A typical axial core is 4-6 inches (~10-15 cm) in diameter and can be over 100 feet (~30 m) long. The rotary motion is typically generated at the surface, and the coring bit is driven into the formation by the weight of the drill string that extends back to the surface. The core sample is broken away from the formation by simply pulling upward on the coring bit that contains the sample.

[0005] By contrast, in "sidewall coring," a core sample is taken from the side wall of a drilled borehole. Sidewall coring is typically performed after the drill string has been removed from the borehole. A wireline coring tool that includes a coring bit is lowered into the borehole, and a small core sample is taken from the sidewall of the borehole.

[0006] In sidewall coring, the drill string cannot be used to rotate the coring bit, nor can it provide the weight required to drive the bit into the formation. Instead, the coring tool must generate both the rotary motion of the coring bit and the axial force necessary to drive the coring bit into the formation.

[0007] In sidewall coring, the available space is limited by the diameter of the borehole. There must be enough space to withdraw and store a sample. Because of this, a typical sidewall core sample is about 1 inch (~2.5 cm) in diameter and less than about 2 inches long (~5 cm). The small size of the sample does not permit enough frictional forces between

the coring bit and the core sample for the core sample to be removed by simply withdrawing the coring bit. Instead, the coring bit is typically tilted to cause the core sample to fracture and break away from the formation.

[0008] An additional problem that may be encountered is that because of the short length of a side wall core sample, it may be difficult to retain the core sample in the coring bit. Thus, a coring bit may also include mechanisms to retain a core sample in the coring bit even after the sample has been fractured or broken from the formation.

[0009] Sidewall coring is beneficial in wells where the exact depth of the target zone is not well known. Well logging tools, including coring tools, can be lowered into the borehole to evaluate the formations through which the borehole passes. Multiple core samples may be taken at different depths in the borehole so that information may be gained about formations at different depths.

[0010] FIG. 1 shows an example of an existing sidewall coring tool **101** that is suspended in a borehole **113** by a wireline **107**, as disclosed in U.S. Pat. No. 6,412,575, which is assigned to the assignee of the present invention. A sample may be taken using a coring bit **103** that is extended from the coring tool **101** into the formation **105**. The coring tool **101** may be braced in the borehole by one or more support arms **111**. An example of a commercially available coring tool is further described in U.S. Pat. Nos. 4,714,119 and 5,667,025, both assigned to the assignee of the present invention.

[0011] FIG. 2 shows a perspective view of an existing coring device **201** taking a core sample **207** from a formation **203**. A coring bit **205** is connected to the coring device **201**, which may include a motor to extend the bit **205** and impart rotary motion to the coring bit **205**. The coring bit **205** extends into the formation **203**, and a core sample **207** is captured in the interior of the coring bit **205**. It is noted that the coring device **201** would typically be disposed in a coring tool (e.g., **101** in FIG. 1) for use downhole. The coring bit **205** would extend from the device **201** and tool (e.g., **101** in FIG. 1) and into the formation **203**.

[0012] Rotary coring tools typically use a hollow cylindrical coring bit with a formation cutter at a distal end of the coring bit. The coring bit is rotated and forced against the wall of the bore hole. As the coring bit penetrates the formation, the hollow interior of the bit receives the core sample. A rotary coring bit is extended from the tool using a shaft of mechanical linkage. The shaft is typically connected to a motor that imparts rotary motion to the coring bit and forces the bit against the formation wall. Rotary coring tools are generally braced against the opposite wall of the bore hole by a support arm. The cutting edge of the rotary coring bit is usually embedded with tungsten carbide, diamonds, or other hard materials for cutting into the formation.

[0013] FIG. 3 shows an example of a conventional rotary coring bit **301** that may be used with a sidewall coring tool, such as the coring tool **101** of FIG. 1. A similar coring bit is disclosed in U.S. Pat. No. 6,371,221, which is assigned to the assignee of the present invention. The coring bit **301** includes a shaft **303** that has a hollow interior **305**. A formation cutting element **307** for drilling is located at one end of the shaft **303**. As the coring bit **301** penetrates a formation (not shown) and a sample core (not shown) may be received in the hollow interior **305** of the bit **301**. After

a sample is received in the hollow interior **305**, the core sample typically is broken from the formation by displacing or tilting the drill system. The coring bit **301** is then removed from the formation, with the core sample retained in the hollow interior **305** of the coring bit **301**. Other known formation cutting elements for a rotary coring bit may be used. Examples of such formation cutting elements are described in copending U.S. patent application Ser. No. 09/832,606, assigned to the assignee of the present invention.

[0014] While existing coring tools are useful, there is still a need for a coring tool that will more effectively ensure a good core sample can be retrieved for analysis.

SUMMARY OF INVENTION

[0015] In one or more embodiments, the invention relates to a sidewall coring tool that includes a tool body, a hollow coring shaft extendable from the tool body, a formation cutter disposed at a distal end of the hollow coring shaft, and a retention member segmented into a plurality of petals and disposed in the hollow coring shaft. In some embodiments, the plurality of petals comprises three petals.

[0016] In some embodiments, the invention relates to a method for taking a core sample that includes extending a coring bit into a formation, receiving the core sample in an internal sleeve having a retention member segmented into a plurality of petals proximate a distal end of the internal sleeve, and withdrawing the coring bit from the formation.

[0017] In some other embodiments, the invention related to a sidewall coring tool that includes a tool body, a hollow coring shaft extendable from the tool body, a formation cutter disposed at a distal end of the hollow coring shaft, an internal sleeve disposed inside the hollow coring shaft, and at least one retention mechanism selected the group consisting of a piston and a check valve, wherein the piston is disposed in the internal sleeve and moveable with respect to the internal sleeve, and the check valve is disposed in the internal sleeve.

[0018] In some embodiments, the intention relates to a method for taking a core sample that includes extending a coring bit into a formation, receiving the core sample in an internal sleeve having a piston disposed therein such that the piston is moveable with respect to the internal sleeve, and withdrawing the coring bit from the formation.

[0019] In some embodiments, the invention relates to a sidewall coring tool that includes a tool body, a hollow coring shaft extendable from the tool body, a formation cutter disposed at a distal end of the hollow coring shaft, and an internal sleeve disposed inside the hollow coring shaft. The internal sleeve may include a bladder configured to apply radial pressure to a core sample when the bladder is selectively filled with a fluid.

[0020] In some embodiments, the invention relates to a sidewall coring tool that includes a tool body, a hollow coring shaft extendable from the tool body, a formation cutter disposed at a distal end of the hollow coring shaft, and an elastic retention member disposed proximate a distal end of coring tool and having an aperture at its center.

[0021] Other aspects and advantages of the invention will be apparent from the following description and the appended claims.

BRIEF DESCRIPTION OF DRAWINGS

[0022] FIG. 1 is a cross-section of a wellbore with a prior art coring tool suspended in the wellbore.

[0023] FIG. 2 is a perspective view of a prior art coring device.

[0024] FIG. 3 is a perspective view of a prior art rotary coring bit.

[0025] FIG. 4A is a cross section of a coring bit in accordance with one embodiment of the invention.

[0026] FIG. 4B is a cross section of a coring bit in accordance with one embodiment of the invention.

[0027] FIG. 4C is a cross section of a coring bit in accordance with one embodiment of the invention.

[0028] FIG. 5A is a cross section of a coring bit with a retention device in accordance with one embodiment of the invention.

[0029] FIG. 5B is a cross section of a coring bit with a retention device in accordance with one embodiment of the invention.

[0030] FIG. 6A is a top view of a coring bit retention member in accordance with one embodiment of the invention.

[0031] FIG. 6B is a top view of a coring bit retention member in accordance with one embodiment of the invention.

[0032] FIG. 6C is a top view of a coring bit retention member in accordance with one embodiment of the invention.

[0033] FIG. 6D is a top view of a coring bit retention member in accordance with one embodiment of the invention.

[0034] FIG. 7A is a cross section of a coring bit retention member in accordance with one embodiment of the invention.

[0035] FIG. 7B is a cross section of a coring bit retention member in accordance with one embodiment of the invention.

[0036] FIG. 7C is a cross section of a coring bit retention member in accordance with one embodiment of the invention.

[0037] FIG. 7D is a cross section of a coring bit retention member in accordance with one embodiment of the invention.

[0038] FIG. 7E is a cross section of a coring bit retention member and internal sleeve in accordance with one embodiment of the invention.

[0039] FIG. 8A is a cross section of a coring bit with a piston in accordance with one embodiment of the invention.

[0040] FIG. 8B is a cross section of a coring bit with a piston in accordance with one embodiment of the invention.

[0041] FIG. 9 is a cross section of a coring bit with a cushion in accordance with one embodiment of the invention.

[0042] FIG. 10 is a cross section of a coring bit with a sample retention device in accordance with one embodiment of the invention.

DETAILED DESCRIPTION

[0043] In some embodiments, the invention relates to a coring bit with a retention member that retains a core sample in a coring bit. In other embodiments, the invention includes a piston or cushion that enables a core sample to be received and retained in a coring tool. In other embodiments, the invention relates to methods for retaining a core sample in a coring tool. The invention will now be described with reference to the attached drawings.

[0044] FIG. 4A is a cross section of a coring bit 401 with a retention member 411 in accordance with one embodiment of the invention. FIG. 4A shows only the coring bit 401, but those having skill in the art will understand that the coring bit 401 forms part of a coring tool (not shown) that is used to take core samples from a formation. By way of example, the coring bit may form part of a coring tool, such as the coring tool 101 in FIG. 1.

[0045] The coring bit 401 in FIG. 4A includes a hollow shaft 403 with a formation cutter 405 disposed at a distal end of the shaft 403. The formation cutter 405, or formation cutter, is formed of a material for drilling into the formation 402. The formation cutter 405 may be formed of a strong material that is coated with a super hard material, such as polycrystalline diamond or tungsten carbide. In other embodiments, the formation cutter 405 may include other devices for cutting through soft formation, such as brushes. The term "distal end" is used to describe the end of the coring bit 401 that first contacts the formation. The distal end is the end of the shaft 403 that is the farthest from the center of the coring tool (not shown) while a sample is being taken. It is the first part of the coring bit 401 to penetrate a formation.

[0046] As shown in FIG. 4A, a coring bit 401 may include an internal sleeve 407 that is disposed inside the hollow shaft 403. The internal sleeve 407 is for receiving a core sample (not shown in FIG. 4A) as it enters the coring bit 401. In some embodiments, the internal sleeve 407 is a "non-rotating" internal sleeve. A non-rotating internal sleeve is an internal sleeve that is free to rotate independent of the hollow shaft 403. Thus, as the coring tool penetrates a formation 402, friction between the internal sleeve and the core sample (e.g., 410 in FIGS. 4B and 4C) prevents the internal sleeve from rotating with respect to the formation 402. In some other embodiments, a mechanical stop, such as a key (not shown) may prevent the rotation of the internal sleeve. This reduces the erosion of the core sample by eliminating friction between the core sample and the internal sleeve during the sampling process. Examples of coring sleeves are disclosed in copending U.S. patent application Ser. No. 10/248,475, assigned to the assignee of the present invention.

[0047] A retention member 411 is disposed at the distal end of the internal sleeve 407. The retention member 411, as will be seen, enables a core sample to enter the coring bit 401 and the internal sleeve 407, and it also retains the core sample 410 in the internal sleeve 407 once the core sample 410 has been received in the coring bit 401.

[0048] FIG. 4B shows a cross section of a coring bit 401 in the process of receiving a core sample 410. As the formation cutter 405 penetrates the formation 402, a core sample 410 enters the coring bit 401. As the core sample 410 enters the internal sleeve 407, it pushes the petals 411a, 411b of the retention member 411 out of the way so that the core sample 410 may enter the coring bit 401. As the petals 411a, 411b move, they apply a radially inward force to the core sample 410 that serves to guide the core sample 410 and hold it in place.

[0049] FIG. 4C shows a cross section of a coring bit 401 that has received a core sample 410 in the internal sleeve 407 disposed inside the hollow shaft 403 of the coring bit 401. The core sample 410 is retained in the coring bit 401 by the petals 411a, 411b of the retention member (411 in FIG. 4A) in at least two ways. First, the petals 411a, 411b press inward on the core sample 410 to stabilize it and hold it in place. Second, when the coring bit 401 retracts from the formation 402, the petals 411a, 411b will tend to close and grip the core sample 410. In hard rock, the additional friction between the core sample 410 and the petals 411a, 411b will act as a wedge gripper that retains the core sample 410 in the coring bit 401.

[0050] In soft rock, the petals 411a, 411b may completely close and trap the core sample 410 in the coring bit 401. This may be advantageous because of the tendency of unconsolidated or soft formations to fall out of the coring bit. Instead of losing $\frac{3}{4}$ inch (~1.9 cm) to 1 inch (~2.5 cm) of the core sample of an unconsolidated formation, the petals 411a, 411b may close to retain the core sample 410 in the coring bit 401. The only core sample 410 that is lost is that part of the core sample that extends past the petals 511a, 511b. In some embodiments, the petals are about $\frac{1}{4}$ inch (~0.6 cm) in length, and about $\frac{1}{4}$ inch of the core sample is lost in the closing of the petals. This assists in capturing and retaining core samples of a soft formation that can simply fall out of the coring bit when the sample is taken using a conventional coring bit.

[0051] The retention member 411 shown in FIGS. 4A, 4B, and 4C is preferably made of rubber, although it can be made of any material that is flexible and still has a memory. A material with a memory will "remember" its original position such that it will tend to move back to its original position whenever it is displaced. In some embodiments, material remains in the elastic deformation regime even when completely displaced by the core sample. Thus, when the petals of a retention member are pushed radially outward by a core sample, the petals are flexible enough to give way so that the core sample can easily enter the coring bit, but they also tend to push radially inward toward their original position. This tendency to move back to the original position is what creates the radial pressure against the core sample that will guide it into the coring bit and retain it there while the coring bit is being withdrawn from the formation.

[0052] In some embodiments, a retention member may not be attached at a distal end of an internal sleeve. For example, FIG. 5A shows a coring bit 501 with an internal sleeve 507 disposed inside a hollow coring shaft 503. A formation cutter 505 is disposed at the distal end of the hollow coring shaft 503. The retention member 511 is located near the mid-point along the axial length of the internal sleeve 507. In this position, a retention member 511 provides guidance so that

a core sample (not shown) will be maintained near the axial center of the internal sleeve 507, while still offering the ability to retain the core sample in the coring bit 501 when the bit is withdrawn from the formation (not shown). For example, in a hard formation, the retention member 511 may act as a wedge gripper that retains the core sample (not shown) in the coring bit 501.

[0053] FIG. 5B shows another embodiment of a coring bit with a retention member 521 in accordance with the invention. The coring bit 521 includes a hollow coring shaft 523 with a formation cutter 525 at its distal end. A retention member 531 is held in the center opening of the formation cutter by a ring 533 in the formation cutter. In this position, the retention member 531 may enable a core sample (not shown) to enter the coring bit 521, and it may also retain the core sample in the coring bit 521 once the sample is received.

[0054] It is noted that a coring bit in accordance with the invention may have various combinations of the described features. For example, may include a retention member located as shown in FIG. 5A, but without an internal sleeve. In another example, a coring bit may include a ring (e.g., ring 533 in FIG. 5B) that is not disposed proximate the distal end of the coring bit. Those having ordinary skill in the art will be able to devise other embodiments of a coring bit that do not depart from the scope of the invention.

[0055] FIG. 6A shows an end view of a retention member 601 in accordance with one embodiment of the invention. The retention member 601 has three petals 602a, 602b, 602c that are cut from the center of the retention member 601 out to an outer petal circumference 605. In some embodiments, the petal circumference 605 is substantially the same size as the inner diameter of the formation cutter (e.g., 505 in FIGS. 5A, 5B, and 5C). This enables the core sample to fit snugly through the retention member. In other embodiments, the petal circumference 605 may be larger than the inner diameter of the formation cutter (e.g., 505 in FIGS. 5A, 5B, and 5C).

[0056] The petals 602a, 602b, 602c shown in FIG. 6A are located adjacent to one another. That is, the edges of one petal, 602a for example, are adjacent to edges on the other petals, 602b, 602c, for example.

[0057] In some embodiments, a retention member 601 includes cuts or perforations 607. The cuts 607 provide additional flexibility for the petals 602a, 602b, 602c when the retention member 601 is constructed of a stiff material or when there are only a small number of petals making each petal stiff.

[0058] FIG. 6B shows an embodiment of a retention member 621 with petals 622a, 622b, 622c that are not adjacent to each other. In this embodiment, the petals 622a, 622b, 622c are separated from each other going back to the petal circumference 625.

[0059] FIG. 6C shows another embodiment of a retention member 631 in accordance with the invention. The petals 637, 638, 639 overlap with each other. For example, petal 637 has edge 637a that overlaps edge 639b of petal 639. The other edge 637b of petal 637 is overlapped by edge 638a of petal 638. Similarly, petal 639 has edge 639a that overlaps edge 638b of petal 638.

[0060] FIG. 6D shows another embodiment of a retention member 641 in accordance with the invention. The retention member includes an aperture 646 at its center. The aperture 646 is created because the retention member 641 extended inwardly only to an aperture circumference 647. A core sample (not shown) may push its way through the aperture 646 by displacing the retention member 641. The elasticity of the retention member 641 will cause the retention member 641 to exert an inward force on the core sample when it is received.

[0061] FIG. 6D also shows some other optional features of a retention member. For example, a retention member 641 with an aperture 646 may not have any petals. A core sample may simply displace a solid retention member. In other embodiments, such as the one shown in FIG. 6D, the retention member 641 may include one or more petals 642a, 642b, 642c. The petals 642a, 642b, 642c may be individual petals, or the petals 642a, 642b, 642c may be perforated with perforations 643 extending between the aperture circumference 647 to the petal circumference 645. When a core sample (not shown) is taken, the core sample will break the perforations 643, and the core sample may be received in the coring bit (not shown).

[0062] In fact, it is noted that the many of the above disclosed embodiments of a retention member may use radial perforations to segment the retention member into petals. This would enable the retention member to serve as a cover that will prevent contaminants from entering the coring bit before a sample is taken and the perforations are broken.

[0063] It is noted that radial perforations are distinguished from circumferential perforations that may be used to increase the flexibility of the retention member.

[0064] FIGS. 7A-7E show various embodiments of a retention member for use with a coring bit in accordance with the invention. FIG. 7A shows a retention member 711 with petals 711a, 711b that are tapered inwardly. The petals 711a, 711b have a petal circumference that is substantially the same as the inner diameter of the formation cutter 705. A core sample will snugly pass through the petals 711a, 711b of the retention member 711.

[0065] FIG. 7B shows another embodiment of a retention member 721 where the petals 721a, 721b are tapered outwardly. In this embodiment, when the petals 721a, 721b are displaced by a core sample (not shown), the pressure applied by the petals 721a, 721b will be slightly greater because they are displaced farther from their original position.

[0066] FIG. 7C shows another embodiment of a retention member 731 in accordance with the invention. The petals 731a, 731b of the retention member 731 are rounded and extruding into the internal sleeve 707. When a core sample (not shown) is received in the internal sleeve 707, the petals 731a, 731b will be displaced inwardly.

[0067] FIG. 7D shows another embodiment of a retention member 741 in accordance with the invention. The petals 741a, 741b of the retention member 741 are rounded and extruding outwardly from the internal sleeve 707. When a core sample (not shown) is received in the internal sleeve 707, the petals 741a, 741b will be displaced inwardly.

[0068] FIG. 7E shows an embodiment of a retention member 751 that is similar to that shown in FIG. 7B. In

FIG. 7E, the internal sleeve **757** has a notch **753** that provides space for the petals **751a**, **751b** in their displaced position. The inner diameter **D2** of the internal sleeve **757** in the notch **753** is larger than the nominal diameter **D1755** of the internal sleeve **757**. In the embodiment shown, the nominal diameter **D1755** of the internal sleeve **757** is substantially the same as the inner diameter of the formation cutter **705**. As a core sample (not shown) passes into the internal sleeve **757**, the petals **751a**, **751b** of the retention member **751** will be displaced into the notch **753**. The petals **751a**, **751b**, when displaced into the notch **753**, have substantially the same inner diameter as the nominal diameter **D1755** of the internal sleeve **757**. This enables the core sample **701** to fit snugly at all points along the axis of the internal sleeve **757**, while still gaining the advantages of a retention member in accordance with embodiments of the invention.

[0069] The embodiment of an internal sleeve **757** that is shown in **FIG. 7E** may be used with various embodiments of a retention member. For example, an internal sleeve **757** with a notch **753** may be used with any of the embodiments of a retention member shown in **FIG. 7A-7E**.

[0070] A retention member in accordance with any of the embodiments of the invention may be designed specifically for a single use, or it may be designed to capture and retain multiple cores. For example, some coring bits are designed so that the core samples are stored in the internal sleeve. That is, the internal sleeve is moved from inside the coring bit into a storage area. In other embodiments, only the core sample is moved into a storage device, and the internal sleeve is used to capture another sample.

[0071] As will be understood by those having ordinary skill in the art, **FIGS. 7A-7E** show a cross section of particular embodiments of a coring bit and a retention member in accordance with the invention. As such, the figures show only two petals in each embodiment. This is simply a function of a cross section, and it is not intended to limit the invention. A retention member in accordance with the invention may have any number of petals. Optionally, the retention member may be uniform, solid, tapered, or have one or more apertures therethrough. Other configurations may be envisioned. The retention member may be adapted to tear and/or stretch as the core sample advances into the sleeve. Portions of the retention member that are stretched or torn may apply force to the core sample to grip the core sample. The retention member is preferably elastic so that it may retract to substantially its original configuration and close behind the core sample thereby restricting portions of the core sample from exiting the coring sleeve.

[0072] **FIG. 8A** shows a cross section of a coring bit **800** with an internal sleeve **807** having a piston **802** in accordance with the invention. The piston **802** is axially moveable with respect to the internal sleeve **807**. The piston **802** is initially positioned proximate the distal end of the internal sleeve **807**. When a core sample is being collected from the formation **810**, the core sample will displace the piston **802** with respect to the internal sleeve **807**. The piston **802** may also include seals **812** or bearings to enable easier movement of the piston **802** within the internal sleeve **807**.

[0073] In the embodiment shown, the internal sleeve **807** has a diameter that is substantially the same as the inner diameter of the formation cutter **805**. In order to fit with the

internal sleeve **807**, the piston **802** has a diameter that is substantially the same as the inner diameter of the internal sleeve **807** so that the piston seals **812** are able to form a seal between the internal sleeve **807** and the piston **802**.

[0074] **FIG. 8B** shows a cross section of the coring bit **800** with a core sample **801** received inside the coring bit **800**. The core sample **801** has displaced the piston **802** to a position proximate the proximal end of the internal sleeve **807**. The piston **802** moves as the core sample **801** is received in the coring bit **800**. Thus, the piston **802** provides support for the core sample **801**. This may be advantageous in unconsolidated formations, where the formation core sample would fall apart as it came into the coring bit. The piston **802** may prevent the formation from falling apart.

[0075] Additionally, when the coring bit **800** is withdrawn from the formation **810**, the piston **802** helps to hold the core sample in the internal sleeve **807**. In some embodiments, the chamber **815** behind the piston **802** includes a check valve or other means (not shown) to allow air or fluid to be pushed out of the chamber **815**, but that will not allow the return flow. Thus, a vacuum behind the piston **802** will prevent the piston **802** from moving on the outward direction.

[0076] In some embodiments, the chamber **815** behind the piston is completely vented. Nonetheless, the core sample **801** may not be able to move out of the internal sleeve **807** without also moving the piston **802**. This may be caused by a vacuum created between the piston **802** and the core sample **801**. The friction between the piston **802** and the internal sleeve **807** will create additional resistance to the movement of the core sample **801**, which will help retain the core sample **801** in the coring bit **800**.

[0077] Further, in addition to a simple piston **802**, the internal sleeve **807** may also include a ratchet device or a locking device. Such a device would prevent the piston from moving in the outward direction.

[0078] **FIG. 9** shows a cross section of a coring bit **900** that includes a cushion for receiving and retaining the core sample **901** in the bit **900**. A hollow outer shaft **903** penetrates a formation **910** using a formation cutter **905** disposed at the distal end of the shaft **903**. A core sample **901** is received in an internal sleeve **917** that is disposed inside the hollow shaft **903**.

[0079] The cavity (shown at **918**) in the internal sleeve **917** behind the core sample **901** is filled with a fluid, such as water. The proximal end of the internal sleeve **917** includes a valve **921** for selectively permitting fluid to pass between the sleeve **917** and the rest of the tool. The valve **921** may be, for example, a check valve that enables the fluid to exit the cavity **918** as a core sample **901** moves into the internal sleeve **917**. When the coring bit **900** is withdrawn from the formation, the valve **921** may be used to prevent the reverse flow of fluid into the cavity **918**, and a vacuum is created behind the core sample **901** that retains the core sample **901** in the coring bit **900**.

[0080] In at least one embodiment, the check valve **921** in **FIG. 9** may be combined with the coring bit **800** in **FIGS. 8A and 8B**. In such an embodiment, the piston (**802** in **FIGS. 8A and 8B**) would force the fluid through the check valve (**921** in **FIG. 9**). The check valve (**921** in **FIG. 9**) would prevent the return flow of fluid and the vacuum

behind the piston (802 in FIGS. 8A and 8B) and, thereby, retain the piston core sample in place.

[0081] FIG. 10 shows a cross section of a coring bit 1001 in accordance with another embodiment of the invention. A hollow shaft 1003 has a formation cutter 1005 at a distal end of the shaft 1003. A bladder 1007 is used as an internal sleeve in the coring bit 1001 in FIG. 10. The bladder 1007, when deflated, provides enough space to accept a core sample. The bladder 1007 may then be selectively inflated by filling it with fluid. The fluid may be stored hydraulic fluid, or it may be drilling mud that is pumped into the bladder. The type of fluid used is not intended to limit the invention.

[0082] When the bladder 1007 is filled, it will compress inwardly and exert a radial pressure on a core sample (not shown). The pressure will apply an overburden to the core sample that will both stabilize and retain the core sample.

[0083] Embodiments of the invention may present one or more of the following advantages. A coring bit with a retention member or other retention device in accordance with the invention will retain the core sample in the coring bit while the coring bit is being withdrawn from the formation. This will prevent the core sample from being damaged or lost during this process.

[0084] Advantageously, a coring bit may include a retention member that will close completely when capturing a sample in soft or unconsolidated formation. When the retention member closes, the core sample will be completely enclosed in the coring bit and protected against further damage and loss.

[0085] Advantageously, a coring bit that includes a non-rotating internal sleeve will not degrade the core sample through friction between the core sample and the internal sleeve and the retention member. The internal sleeve and the retention member will not rotate with respect to the formation and the core sample as it is being captured.

[0086] Advantageously, embodiments of the invention that include a piston in the internal sleeve provide additional guidance for a core sample as it is being received. The piston is displaced by the core sample, and once the sample is fully received, the piston creates a vacuum or void behind the core sample that retains the core sample in the internal sleeve as the coring bit is withdrawn from the formation.

[0087] Advantageously, embodiments of the invention that include a cushion provide steady guidance for the core sample as it enters the coring bit. Once received in the coring bit, the core sample is retained by a vacuum or void behind the core sample.

[0088] While the invention has been described with respect to a limited number of embodiments, those skilled in the art, having benefit of this disclosure, will appreciate that other embodiments can be devised which do not depart from the scope of the invention as disclosed herein. Accordingly, the scope of the invention should be limited only by the attached claims.

1. A sidewall coring tool, comprising:

a tool body;

a hollow coring shaft extendable from the tool body;

a formation cutter disposed at a distal end of the hollow coring shaft; and

a retention member defining one of a plurality of petals, an aperture and combinations thereof, the retention member disposed in the hollow coring shaft.

2. The sidewall coring tool of claim 1, further comprising an internal sleeve disposed inside the hollow coring shaft, and wherein the retention member is connected to the internal sleeve.

3. The sidewall coring tool of claim 2, wherein the retention member is disposed proximate a distal end of the internal sleeve.

4. The sidewall coring tool of claim 2, wherein the internal sleeve comprises a non-rotating sleeve.

5. The sidewall coring tool of claim 2, wherein the internal sleeve comprises a radial notch such that the petals of the retention member can be positioned radially outward into the notch.

6. The sidewall coring tool of claim 5, wherein the retention member has a petal circumference that is substantially the same as an inner diameter of the internal sleeve.

7. The sidewall coring tool of claim 2, further comprising a piston disposed inside the internal sleeve and axially moveable with respect to the internal sleeve.

8. The sidewall coring tool of claim 2, further comprising a check valve disposed in the internal sleeve.

9. The sidewall coring tool of claim 8, wherein the check valve is disposed in a proximal end of the internal sleeve.

10. The sidewall coring tool of claim 9, wherein the check valve enables a fluid to flow out of the internal sleeve.

11. The sidewall coring tool of claim 1, wherein an inner diameter of the internal sleeve is substantially the same as an inner diameter of the formation cutter.

12. The sidewall coring tool of claim 1, wherein an inner diameter of the internal sleeve is larger than an inner diameter of the formation cutter.

13. The sidewall coring tool of claim 1, wherein the internal sleeve comprises a bladder configured to apply radial pressure to a core sample when the bladder is selectively filled with a fluid.

14. The sidewall coring tool of claim 1, wherein the plurality of petals comprises 3 petals.

15. The sidewall coring tool of claim 1, wherein the plurality of petals overlap.

16. The sidewall coring tool of claim 1, wherein the plurality of petals are separated by gaps.

17. The sidewall coring tool of claim 1, wherein the retention member comprises perforations.

18. The sidewall coring tool of claim 17, wherein the perforations are circumferential perforations disposed outside a petal circumference.

19. The sidewall coring tool of claim 17, wherein the perforations are radial perforations disposed at least partially inside a petal circumference.

20. The sidewall coring tool of claim 1, wherein the plurality of petals are adjacent.

21. The sidewall coring tool of claim 1, wherein the retention member is constructed of rubber.

22. The sidewall coring tool of claim 1, wherein the retention member is rounded and extrudes towards a distal end of hollow coring shaft.

23. The sidewall coring tool of claim 1, wherein the retention member is rounded and extrudes towards a proximal end of the hollow coring shaft.

24. A method for taking a core sample, comprising:
 extending a coring bit into a formation, the coring bit having a retention member segmented into a plurality of petals;
 receiving the core sample in the coring bit; and
 retaining the core sample in the coring bit with the retention member while withdrawing the coring bit from the formation.

25. The method of claim 24, further comprising selectively filling a bladder with a fluid to apply a radial pressure to the core sample.

26. The method of claim 24, wherein the retention member is connected to an internal sleeve disposed in the coring bit and the core sample is received in the internal sleeve.

27. A sidewall coring tool, comprising:
 a tool body;
 a hollow coring shaft extendable from the tool body;
 a formation cutter disposed at a distal end of the hollow coring shaft;
 an internal sleeve disposed inside the hollow coring shaft; and
 at least one retention mechanism selected from the group consisting of a piston and a check valve, wherein the piston is disposed in the internal sleeve and moveable

with respect to the internal sleeve, and the check valve is disposed in the internal sleeve.

28. The sidewall coring tool of claim 27, wherein the at least one retention mechanism is the piston.

29. The sidewall coring tool of claim 28, further comprising a seal disposed between the piston and the internal sleeve.

30. The sidewall coring tool of claim 28, wherein an inner diameter of the internal sleeve is substantially the same as an inner diameter of the formation cutter.

31. The sidewall coring tool of claim 28, further comprising a check valve operatively connected to the internal sleeve.

32. The sidewall coring tool of claim 27, further comprising a retention member segmented into petals disposed proximate an opening at a distal end of the internal sleeve.

33. A method for taking a core sample, comprising:
 extending a coring bit into a formation;
 receiving the core sample in an internal sleeve having a piston disposed therein such that the piston is moveable with respect to the internal sleeve; and
 withdrawing the coring bit from the formation.

34. The method of claim 33, further comprising selectively filling a bladder with a fluid to apply a radial pressure to the core sample.

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