A downhole tool may include a body with a flow channel therethrough. The flow channel may be an outer flow channel that is radially outward relative to an inner flow channel and/or a rod. The rod or inner flow channel may act as a valve to allow flow within the outer flow channel. A plunger may be positioned within the body and acted upon by fluid in the inner flow channel or the rod. The plunger may move from a first position that restricts fluid flow from the outer flow channel to a chamber in the body to a second position that allows fluid flow from the outer flow channel to the chamber in the body at least partially in response to fluid flowing through the inner flow channel. An expandable member, such as a cutting tool or isolation tool, may be movably coupled to the body.
SYSTEMS AND METHODS FOR ACTIVATING A DOWNHOLE TOOL

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of, and priority to, 62/009,747 filed Jun. 9, 2014, and 62/009,742 filed Jun. 9, 2014, which applications are expressly incorporated herein by this reference in their entirety.

BACKGROUND

[0002] A bottomhole assembly of a drilling system includes a drill bit for drilling a wellbore into a subterranean formation. An underreamer may be coupled to the bottomhole assembly and positioned above the drill bit. The underreamer includes one or more cutter blocks that can be activated to move radially from a retracted position to an expanded position. In the retracted position, the cutter blocks rotate and move from a recess in the body of the underreamer. To move to the expanded position, the cutter blocks expand radially outward. The bottomhole assembly rotates and the expanded cutter blocks cut or grind the formation around a wellbore to increase the diameter of the wellbore. The bottomhole assembly is raised or lowered in the wellbore to ream along a length of the wellbore.

[0003] An underreamer is activated by the flow of fluid from the surface. Fluid flows through the drill string and into a bore of the underreamer. The pressure of the fluid in the bore may cause the cutter blocks to move radially outward into the expanded position. In some cases, a piston may receive the fluid and press against and expand the cutter blocks.

SUMMARY

[0004] An activation system for a downhole tool or other assembly or system may include a body having an outer flow channel and a chamber. A valve within the body may include an inner flow channel that is radially inward relative to the outer flow channel. A plunger may be movable in response to fluid within the inner flow channel, and may move from a first position that restricts fluid flow from the outer flow channel to the chamber in the body to a second position that allows fluid flow from the outer flow channel to the chamber in the body. An expandable component may be coupled to the body and may move radially from a retracted position to an expanded position when fluid flows into the chamber.

[0005] In some embodiments, a downhole tool includes a body with an outer flow channel therein. A valve may be within the body and may include an inner flow channel that is radially inward relative to the outer flow channel. A mandrel within the body may include an opening that provides a path of fluid communication from the outer flow channel to a chamber in the body. A plunger coupled to the mandrel may move when fluid flows through the inner flow channel. The mandrel may move from a first position to a second position. In the first position, the mandrel may restrict fluid flow from the outer flow channel, through the opening in the mandrel, to the chamber in the body, while in the second plunger the fluid flow may be allowed. An expandable cutting tool (e.g., reamer cutter block, section mill blade, pipe cutter, etc.), expandable isolation tool (e.g., packer, bridge plug, etc.), or other expandable tool (e.g., anchor) may be coupled to the body, and may move from a retracted position to an expanded position in response to fluid flowing into the chamber in the body.

[0006] According to another embodiment, a method for activating a downhole tool includes running a downhole tool into a wellbore, introducing a first ball into the downhole tool, and supplying fluid to the downhole tool. The downhole tool may include a body having an outer flow channel, and a valve within the body. The valve may include an inner flow channel positioned radially inward relative to the outer flow channel. A first sleeve within the body may be coupled to a first seat. A plunger within the body may be in fluid communication with the inner flow channel, and a cutter block may be movably coupled to the body. When the first ball is introduced into the downhole tool, the first ball may be received by the first seat. Fluid supplied to the downhole tool may build behind the first ball and cause the first ball to pass through the first sleeve. The fluid may also move the first sleeve axially within the body in response to the first ball passing through the first sleeve. The plunger may also be moved from a first position that restricts fluid flow from the outer flow channel to a chamber in the body to a second position that allows fluid flow from the outer flow channel to the chamber in the body in response to fluid flowing into the inner flow channel.

[0007] Another embodiment of an activation system includes a body with a flow channel therein. A rod may extend through the body and move relative to the body. The rod may be radially inward relative to the flow channel. An expandable element coupled to the body may move radially from a retracted position to an expanded position. The expandable element may be radially outward relative to the rod, and movement of the expandable element may be in response to axial movement of the rod. Flow in the flow channel may contact the rod, or may not be in contact with the rod.

[0008] In another embodiment, a downhole tool may include a body with a flow channel. A rod may extend through a portion of the body, move relative to the body, and be located radially inward relative to the flow channel. A first sleeve within the body may be coupled to an end of the rod and move with the rod. A mandrel within the body may be radially inward relative to the flow channel, and may include a radial opening providing a path of fluid communication from the flow channel to a chamber in the body. A plunger within the mandrel may be coupled to another end of the rod, and may move with the rod from a first position that restricts fluid flow through the opening in the mandrel. An expandable cutting tool may move relative to the body. The expandable cutting tool may be radially outward relative to the rod, and may be axially between the first sleeve and the plunger. The expandable cutting tool may move radially from a retracted position to an expanded position in response to fluid flowing through the body.

[0009] A method for activating a downhole tool may include running a downhole tool into a wellbore. The downhole tool may include a body with a flow channel, and a rod that is radially inward relative to the flow channel. A first sleeve within the body may be coupled to a first end portion of the rod. A plunger may be coupled to a second end of the rod, and a cutter block may be movably coupled to the body. A first ball may be introduced into the downhole tool from a surface or downhole location and passed to a seat of the first sleeve in the body, thereby causing the first sleeve, the rod, and the plunger to move from a first axial position to a second axial position.
This summary is provided to introduce a selection of concepts that are further described below in the detailed description. This summary is not intended to identify key or essential features of the claimed subject matter, nor is it intended to be used as an aid in limiting the scope of the claimed subject matter.

BRIEF DESCRIPTION OF THE DRAWINGS

So that the recited features may be understood in detail, a more particular description may be had by reference to one or more embodiments, some of which are illustrated in the appended drawings. It is to be noted, however, that the appended drawings are illustrative embodiments, and are, therefore, not to be considered limiting of the scope of the present disclosure or the claims.

FIGS. 1 and 2 are cross-sectional views of an illustrative downhole tool, according to one or more embodiments of the present disclosure.

FIG. 3 is a cross-sectional view of an illustrative control module of a downhole tool, according to one or more embodiments of the present disclosure.

FIG. 4 is a cross-sectional view of an illustrative activation module of a downhole tool, according to one or more embodiments of the present disclosure.

FIGS. 5 through 8 are cross-sectional views of a control module having an activation sleeve to activate a downhole tool, according to one or more embodiments of the present disclosure.

FIGS. 9 and 10 are cross-sectional views of a control module having a deactivation sleeve to deactivate a downhole tool, according to one or more embodiments of the present disclosure.

FIG. 11 is a cross-sectional view of a control module having activation and deactivation sleeves, according to one or more embodiments disclosed.

FIGS. 12 and 13 are cross-sectional views of another illustrative downhole tool, according to one or more embodiments of the present disclosure.

FIG. 14 is a cross-sectional view of an illustrative control module of a downhole tool, according to one or more embodiments of the present disclosure.

FIG. 15 is a cross-sectional view of an illustrative activation module of a downhole tool, according to one or more embodiments of the present disclosure.

FIGS. 16 through 22 are cross-sectional views of a control module having activation and deactivation sleeves for activating and deactivating a downhole tool, according to one or more embodiments of the present disclosure.

DETAILED DESCRIPTION

Some embodiments of the present disclosure relate generally to downhole tools. More particularly, some embodiments of the present disclosure relate to systems, methods, and tools for activating a downhole tool.

FIG. 1 is a cross-sectional view of an illustrative downhole tool 100, according to one or more embodiments of the present disclosure. Although shown as an underreamer in FIG. 1, it will be appreciated that the downhole tool 100 may be or include any tool that is configured to be run into a wellbore. For example, the downhole tool 100 may be or include an underreamer, a pipe cutter, a section mill, a bypass valve, a whipstock anchor, a measuring-while-drilling (“MWD”) tool, a logging-while-drilling (“LWD”) tool, a bridge plug, a packer, a sidetracking system, other tools, or any combination of the foregoing.

The downhole tool 100 may include a body 110 having an “upper” or first end portion 112 and a “lower” or second end portion 114. The body 110 may be a single component or two or more components coupled together. In some embodiments, the body 110 may be substantially cylindrical and have a substantially circular cross-sectional shape. In other embodiments, however, the body 110 may have other structures, and may have triangular, rectangular, hexagonal, octagonal, or other regular or irregular cross-sectional shapes.

The downhole tool 100 may include one or more devices, tools, or other components that are configured to be activated. When activated the components may transition or otherwise move from a first position to a second position. As shown in FIG. 1, for instance, the moveable components may be or include one or more cutter blocks 120 that are movably coupled to the body 110. Although a single cutter block 120 is shown in FIG. 1, the number of cutter blocks 120 may vary. For instance, there may be between 1 and 20 cutter blocks 120. More particularly, the number of cutter blocks 120 may be within a range having lower and upper limits that include any of 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 12, 15, 20, or who numbers therebetwen. For example, as shown in FIG. 2, the body 110 may have 5 cutter blocks 120 that are circumferentially offset from one another. In other embodiments, the body 110 may have 4, 6, or 8 cutter blocks 120, or between 2 and 10, between 3 and 9, or between 2 and 4 cutter blocks 120 coupled thereto circumferentially, or angularly, offset around the body 110. In still other embodiments, more than 20 cutter blocks 120 may be used. In other embodiments, the cutter blocks 120 may be other types of expandable cutting elements, including, but not limited to, section mill blades, casing cutters, or the like.

The cutter blocks 120 may be activated from a first or retracted position (as shown in FIG. 1) to a second or expanded position. When the cutter blocks 120 are in the retracted position, the cutter blocks 120 may be folded or withdrawn into corresponding recesses 121 in the body 110. In at least one embodiment, when the cutter blocks 120 are in the retracted position, outer radial surfaces 122 of the cutter blocks 120 may be aligned with, or positioned radially inward from, an outer radial surface 116 of the body 110. In another embodiment, when the cutter blocks 120 are in the retracted position, the outer radial surfaces 122 of the cutter blocks 120 may be positioned slightly radially outward from the outer radial surface 116. In at least some embodiments, when the outer radial surfaces 122 of the cutter blocks 120 are radially outward relative to the outer radial surface 116 of the body 110, the cutter blocks 120 may stabilize the body 110 as the body 110 rotates and/or moves axially within a wellbore.

The cutter blocks 120 may pivot, translate, or both pivot and translate to expand and retract. In some embodiments, the cutter blocks 120 may translate along a predetermined path. For instance, the cutter blocks 120 may include a one or more splines 124 formed on the outer side surfaces thereof. The splines 124 may also include grooves, teeth, ridges, or other guide structures. The one or more splines 124 may be, or may include, a single ridge or protrusion, or multiple offset ridges or protrusions, configured to engage one or more corresponding grooves 125 (see FIG. 2) in the body 110. In some embodiments, the splines 124 on the cutter blocks 120 (and the corresponding grooves 125 in the body...
110) may be oriented at an angle with respect to a central longitudinal axis through the body 110. In some embodiments, the angle may be between 2° and 35°. More particularly, the angle may be within a range having lower and upper limits that include any of 2°, 5°, 10°, 12°, 15°, 17°, 20°, 23°, 25°, 28°, 30°, or any value therebetween. For instance, the angle may be between 15° and 25° or between 17° and 23°. In other embodiments, the angle may be less than 2° or greater than 35°.

[0028] When the cutter blocks 120 are activated from the retracted position to the expanded position, the engagement of the splines 124 on the cutter blocks 120 and the grooves in the body 110 may cause the cutter blocks 120 to simultaneously move axially and radially. For instance, the cutter blocks 120 may move axially toward the first end portion 112 of the body 110 while moving radially outwardly (i.e., away from the central longitudinal axis of the body 110). The resultant movement from the combined axial and radial movement may be at an angle corresponding to the angle of the splines 124 and/or grooves 125 (e.g., between 15° and 25° with respect to the longitudinal axis through the body 110). The resultant path the cutter blocks 120 travel may be linear, curved, or may have a combination of linear and curved portions.

[0029] When the cutter blocks 120 are in an expanded position, the outer radial surfaces 122 of the cutter blocks 120 may be positioned radially outward from the outer radial surface 116 of the body 110. In some embodiments, when the cutter blocks 120 are in the expanded position, a distance between the central longitudinal axis of the body 110 and the outer radial surfaces 122 of the cutter blocks 120 (i.e., an “expanded radius”) may be between 102% and 150% of a distance between the central longitudinal axis of the body 110 and the outer radial surface 116 of the body 110 (i.e., a “body radius,” as shown in radius 118 in FIG. 2). More particularly, the expanded radius may be within a range having lower and upper limits that include any of 102%, 105%, 110%, 115%, 120%, 125%, 130%, 135%, 140%, 145%, 150%, or any value therebetween relative to the body radius. For instance, the expanded radius may be between 105% and 150%, between 115% and 140%, or between 125% and 145% of the body radius. In other embodiments, the expanded radius may be less than 102% or greater than 150% of the body radius.

[0030] The cutter blocks 120 may include cutting structures suitable for cutting, shearing, impacting, crushing, or otherwise deforming a formation in which the underreamer 100 is used. In some embodiments, the cutter blocks 120 may each include a plurality of cutting contacts or elements coupled to, or formed on, the outer radial surface 122 of the corresponding cutter block 120. The cutting elements coupled to or formed on the cutter blocks 120 may be made from any number of suitable materials (e.g., polycrystalline diamond, cubic boron nitride, tungsten carbide, etc.). The cutting elements may cut, grind, shear, crush, or otherwise deform the wall of the wellbore, thereby increasing the diameter of the wellbore when the cutter blocks 120 are in the expanded position. The cutter blocks 120 may also include one or more stabilizer or gauge protection pads or features on the outer radial surface 122 thereof.

[0031] According to some embodiments of the present disclosure, the downhole tool 100 may include a control module 300 and an activation module 400. Example embodiments of a control module 300 and an activation module 400 are discussed in greater detail herein. In some embodiments, the control module 300 may control flow of fluid through the outer flow channels 140 while the activation module 400 may activate the cutter blocks 120. Operation of the control module 300 and the activation module 400 may be linked, or the control module 300 and the activation module 400 may be combined. In some embodiments, the control module 300 and the activation module 400 may collectively act as an activation system.

[0032] Optionally, the control module 300 may be positioned axially between the first end portion 112 of the body 110 and the cutter blocks 120. Thus, in some embodiments, the control module 300 may be closer to the surface of a wellbore when compared to the cutter blocks 120. In at least some embodiments, the activation module 400 may be positioned axially between the cutter blocks 120 and the second end portion 114 of the body 110. Thus, the activation module 400 may be farther from the surface of a wellbore than the cutter blocks 120.

[0033] FIG. 2 is a cross-sectional view of the downhole tool 100 through line 2-2 in FIG. 1, according to one or more embodiments of the present disclosure. FIG. 2 shows three (3) cutter blocks 120 that are circumferentially offset from one another and in a retracted position relative to the body 110. In the illustrated embodiment, the cutter blocks 120 are shown as being expandable and retractable along a radial path directed toward a central axis of the downhole tool 100. Thus, as the cutter blocks 120 are retracted, they may move toward a common center of the body 110 of the downhole tool 100. Some embodiments are in a template cutter blocks 120 that may be expandable to have an expanded radius up to 200% of the body radius (i.e., the distance between the outer surface 116 of the body 110 and a central longitudinal axis of the body 110). One skilled in the art should appreciate in view of the disclosure herein that as the difference between the expanded radius and the body radius increases, the height 126 of the cutter blocks 120 may also increase. As a result, when the cutter blocks 120 are retracted, the cutter blocks 120 may move into, and potentially obstruct, a flow area or bore extending axially along the body 110. Any region of a bore unobstructed by the cutter blocks 120 may, in some embodiments, limit the amount of fluid flow through the bore, or limit the ability to pass a ball, dart, or other impediment through the downhole tool 100.

[0034] In some embodiments, a rod 130 may extend axially through at least a portion of the body 110. The rod 130 may be positioned radially inward from the cutter blocks 120, and in some embodiments may serve as a support structure for the body 110. The rod 130 may be stationary with respect to the body 110. In other embodiments, the rod 130 may move rotate or translate relative to the body 110. In some embodiments, the rod 130 may be co-axial with, or parallel to, a central longitudinal axis of the body 110.

[0035] An inner flow channel 132 may extend axially through at least a portion of the rod 130. The inner flow channel 132 may provide a path of fluid communication from the control module 300 to the activation module 400, as described in greater detail herein. In some embodiments, the inner flow channel 132 may have a cross-sectional area between 0.05 cm² and 10 cm². More particularly, the cross-sectional area of the inner flow channel 132 may be within a range having lower and upper limits that include any of 0.5 cm², 0.1 cm², 0.25 cm², 0.5 cm², 1 cm², 2 cm², 3.5 cm², 5 cm², 7.5 cm², 10 cm², 15 cm², 20 cm², and any value therebetween. For instance, the cross-sectional area of the inner flow chan-
nel 132 may be between 0.1 cm$^2$ and 0.5 cm$^2$, between 0.5 cm$^2$ and 2 cm$^2$, between 2 cm$^2$ and 5 cm$^2$, or between 0.1 cm$^2$ and 5 cm$^2$. In other embodiments, the cross-sectional area of the inner flow channel 132 may be less than 0.05 cm$^2$ or greater than 10 cm$^2$.

[0036] A central bore and/or one or more outer flow channels 140 may extend axially through the body 110. In a particular embodiment, as shown in FIG. 2, the outer flow channels 140 may be positioned radially outward from the rod 130. In some embodiments, there may be between 1 and 40 outer flow channels 140. More particularly, the number of outer flow channels 140 may be within a range having lower and upper limits that include any of 1, 2, 3, 4, 6, 8, 10, 12, 15, 20, 30, 40, or any values therebetween. For instance, there may be between 1 and 4, between 2 and 8, or between 3 and 15 outer flow channels 140. Thus, while three (3) outer flow channels 140 are shown, it should be appreciated in view of the disclosure herein that the number of outer flow channels 140 is merely illustrative. Indeed, in other embodiments there may even be more than 40 outer flow channels 140. In at least some embodiments, the number of outer flow channels 140 may be equal to the number of cutter blocks 120. In the same or other embodiments, the outer flow channels 140 may be positioned circumferentially between adjacent cutter blocks 120.

[0037] The circumferential or angular offset or spacing between the outer flow channels 140 may also be varied. In some embodiments, for instance, the circumferential offset may be substantially equal between outer flow channels 140. In other embodiments, however, the circumferential offset may not be equal. Where the outer flow channels 140 are equally circumferentially offset from one another, the amount of offset may vary between 90$^\circ$ (40 outer flow channels 140) and 180$^\circ$ (2 outer flow channels 140). Thus, the circumferential offset may also range from 30$^\circ$ to 60$^\circ$, 60$^\circ$ to 90$^\circ$, 90$^\circ$ to 120$^\circ$, 120$^\circ$ to 150$^\circ$, or 150$^\circ$ to 180$^\circ$. As shown, there may be between a 100$^\circ$ and 130$^\circ$ circumferential offset between outer flow channels 140. In other embodiments—including when more than 40 outer flow channels 140 are included, or when the circumferential offset is not equal between outer flow channels 140—the circumferential offset may be less than 90$^\circ$ or greater than 180$^\circ$.

[0038] The outer flow channels 140 may collectively and individually provide a cross-sectional area sufficient to allow fluid to flow through the downhole tool 100, activate the cutter blocks 120, or perform other desired functions. In some embodiments, the outer flow channels 140 may individually have a cross-sectional area between $1/4$ cm$^2$ and 40 cm$^2$. More particularly, the cross-sectional area of the outer flow channels 140 may be within a range having lower and upper limits that include any of $1/4$ cm$^2$, $1/2$ cm$^2$, $3/4$ cm$^2$, 1 cm$^2$, 2 cm$^2$, 5 cm$^2$, 10 cm$^2$, 15 cm$^2$, 20 cm$^2$, 30 cm$^2$, 40 cm$^2$, and any values therebetween. For instance, the cross-sectional area of the outer flow channels 140 may be between 1 cm$^2$ and 5 cm$^2$, between 5 cm$^2$ and 10 cm$^2$, between 10 cm$^2$ and 20 cm$^2$, between 1 cm$^2$ and 20 cm$^2$. The aggregate cross-sectional area of the outer flow channels 140 may correspondingly vary. For instance, the aggregate cross-sectional area of the outer flow channels 140 may be between $1/4$ cm$^2$ and 1600 cm$^2$. In more particular examples, the aggregate cross-sectional area of the outer flow channels 140 may be between 5 cm$^2$ and 15 cm$^2$, between 15 cm$^2$ and 30 cm$^2$, or between 30 cm$^2$ and 60 cm$^2$.

[0039] The outer flow channels 140 may also be equally or unequally radially distributed within the body 110. In other words, some outer flow channels 140 may have different radial positions within the body 110, or each outer flow channel 140 may be at a same radial position. In at least some embodiments, a center of an outer flow channel 140 may be positioned at a distance that is between 10% and 75% of the body radius, which is the distance from the outer surface 116 of the body 110 to the central longitudinal axis of the body 110. For instance, one or more of the outer flow channels 140 may be set at a distance from the central longitudinal axis of the body 110 that is between 10% and 30%, between 20% and 50%, between 30% and 60%, or between 35% and 60% of the body radius.

[0040] In at least some embodiments, the body 110 may include a coating or lining on the inner surface defining the outer flow channels 140. Such a coating or lining may reduce erosion of the body 110 when fluid flows through the outer flow channels 140 at a high velocity. The coating or lining may therefore be referred to as an erosion resistant coating. In another embodiment, an erosion protection sleeve (not shown) may be disposed in each of the outer low channels 140. The erosion protection sleeve may have an axial bore through which fluid may flow. The protection sleeve may be made of a hard material, such as carbide, or may be covered with an erosion resistant coating.

[0041] As discussed herein, by placing the outer flow channels 140 circumferentially between the cutter blocks 120, rather than radially inward from the cutter blocks 120 (i.e., as a central bore), the cutter blocks 120 may have an increased height 126. In some embodiments, the cutter blocks 120 may have a height 126 between 10 mm and 200 mm. More particularly, the height 126 may be within a range having lower and upper limits that include any of 10 mm, 15 mm, 20 mm, 25 mm, 30 mm, 40 mm, 50 mm, 60 mm, 75 mm, 90 mm, 100 mm, 200 mm, or any values therebetween. For instance, the height 126 may range 30 mm to 70 mm, from 40 mm to 60 mm, or from 45 mm to 55 mm. In other embodiments, the height 126 may be less than 10 mm or greater than 200 mm. In some embodiments, a ratio of the height 126 of the cutter blocks 120 to a radius 118 of the body 110 may be from 0.4:1 to 0.9:1. For instance, the ratio of the height 126 to the radius 118 may be between 0.65:1 and 0.95:1, between 0.7:1 and 0.9:1, or between 0.75:1 and 0.85:1. In other embodiments, the ratio of the height 126 to the radius 118 may be less than 0.4:1 or greater than 0.9:1. In some embodiments, the ratio of the height 126 to the radius 118 may be even greater than 1:1 (e.g., where the cutter blocks 122 are offset such that the path of fluid communication and reaction is not directed through the central longitudinal axis of the body 110, where the cutter blocks 122 are axially offset, etc.).

[0042] FIG. 3 is a cross-sectional view of one example embodiment of a control module 300 of a downhole tool 100. The control module 300 may include a first or “activation” sleeve 310. In some embodiments, the activation sleeve 310 may be located fully or partially within the body 110. The activation sleeve 310 may be flush with the inner surface of the body 110. In other embodiments, the activation sleeve 310 may be positioned at least partially within a fluid chamber 320 extending from the inner surface of the body 110 to the outer flow channels 140 in the body 110. In some embodiments, the activation sleeve 310 may be configured to receive...
an impediment (e.g., a dart or ball), as discussed in greater detail herein. In some embodiments, the outer surface of the activation sleeve 310 may define or be coupled to a shoulder 318. A first or "activation" spring 320 may be in contact with the shoulder 318. In some embodiments, the activation spring 320 may be positioned radially outward from, or even at least partially around, the activation sleeve 310. The activation spring 320 may be a compression spring, and represents one example of a biasing member that may be used to position the activation sleeve 310, or to assist or resist movement of the activation sleeve 310. In other embodiments, torsional springs, shocks, hydraulic pre-loading, or other components or mechanisms may be used as a biasing member.

[0044] The control module 300 may include a second or "deactivation" sleeve 330. In FIG. 3, for instance, the deactivation sleeve 330 is shown as being located between the first end portion 112 of the body 110 and the activation sleeve 310 (i.e., above the activation sleeve 310). The axial bore 312 may extend through the deactivation sleeve 330. Instead of, or in addition to, the openings 314 in the activation sleeve 310, the one or more openings 314 may be formed radially through the deactivation sleeve 330.

[0045] The deactivation sleeve 330 may include, or be coupled to, a seat 336. The seat 336 may, in some embodiments, be formed in the inner surface of the deactivation sleeve 330 and/or configured to receive an impediment (e.g., a dart or ball) that may be the same or different than the impediment to be received by the seat 316. According to some embodiments of the present disclosure, the seat 336 of the deactivation sleeve 330 may have a larger inner diameter than the seat 316 of the activation sleeve 310. The outer surface of the deactivation sleeve 330 may include, be coupled to, or define a shoulder 338. A second or "deactivation" spring 340 may contact with the shoulder 338 of the deactivation sleeve 330. The deactivation spring 340 may be positioned radially outward from, and potentially around at least a portion of, the deactivation sleeve 330. In some embodiments, a spring coefficient of the deactivation spring 340 may be larger than a spring coefficient of the activation spring 320. The deactivation spring 340 is also an example of a biasing member, but other biasing members as would be understood by a person having ordinary skill in the art in view of the present disclosure may also be used.

[0046] In some embodiments, a cap 350 may be positioned at least partially around the activation sleeve 310 and/or the deactivation sleeve 330. The cap 350 may be an annular cap and/or may be stationary with respect to the body 110. In one or more embodiments, the activation sleeve 310 may be coupled to the cap 350 (and indirectly to the body 110) using one or more shear pins 352, shear screws, burst discs, or other shear elements. The activation spring 320 may be compressed or positioned between the cap 350 and the shoulder 318 of the activation sleeve 310 when the shear pins 352 couple the activation sleeve 310 to the cap 350. As shown in FIG. 3, the activation spring 320 may be positioned inside the cap 350. Similarly, the deactivation sleeve 330 may be coupled to the cap 350 (and indirectly to the body 110) using one or more shear pins 354. The deactivation spring 340 may be compressed or positioned between the shoulder 338 and a portion of the body 310 when the shear pins 354 couple the deactivation sleeve 330 to the cap 350. The activation sleeve 310 and the deactivation sleeve 330 may be in first axial positions when coupled to the cap 350 with the shear pins 352, 354.

[0047] The control module 300 may also include a valve 360, which may be located within the body 110 in some embodiments. The valve 360 may be positioned (at least partially) axially between the activation sleeve 310 and the activation module 400. As shown, at least a portion of the valve 360 may be located within the activation sleeve 310. According to some embodiments, the inner flow channel 132 may extend at least partially axially through the valve 360. The valve 360 may have one or more openings 362 formed radially therethrough, and which provide a path of fluid communication into the inner flow channel 132. When the activation sleeve 310 is in the first axial position, as shown in FIG. 3, the activation sleeve 310 may restrict or potentially prevent fluid flow through the openings 362 in the valve 360 and into the inner flow channel 132. One or more seals 364 (e.g., O-rings, C-rings, T-rings, elastomers, etc.) may be positioned around an outer surface of the valve 360 to create a fluid seal between the outer surface of the valve 360 and the inner surface of the activation sleeve 310.

[0048] FIG. 4 is a cross-sectional view of the activation module 400 of the downhole tool 100, according to one or more embodiments of the present disclosure. The activation module 400 may include a mandrel 410 located within the body 110. The mandrel 410 may have an annular configuration and may have one or more openings 412 formed radially therethrough. The openings 412 may provide a path of fluid communication from the outer flow channels 140 in the body 110 to a chamber 414 in the body 110.

[0049] A plunger 420 may be positioned inside the body 110, and potentially within the mandrel 410. The plunger 420 may be configured to move axially within the mandrel 410 at least partially in response to a pressure differential between a first axial side 422 and a second axial side 424 of the plunger 420. The first axial side 422 of the plunger 420 may be in fluid communication with the fluid in the inner flow channel 132. The second axial side 424 of the plunger 420 may be in fluid communication with an annulus formed between the outer radial surface 116 of the body 110 and the wellbore wall.

[0050] When the activation sleeve 310 restricts and potentially prevents fluid from flowing into the inner flow channel 132, as shown in FIG. 3, the pressure differential between the first and second axial sides 422, 424 of the plunger 420 may be nominal. In some embodiments, a spring 426 or other biasing member located at least partially in the mandrel 410 may be compressed, loaded, or have a bias force overcome. When the force exerted on the plunger 420 by the spring 426 is greater than the force exerted on the plunger 420 by the fluid and pressure differential, the plunger 420 may be in a first axial position, as shown in FIG. 4. In the first axial position, the plunger 420 may restrict or even prevent fluid from flowing from the outer flow channels 140 into the chamber 414. More particularly, the plunger 420 may prevent fluid from flowing from the outer flow channels 140, through the openings 412 in the mandrel 410, and to the chamber 414 by being axially aligned with and obstructing the openings 412 in the mandrel 410. One or more seals 416 (e.g., O-rings, C-rings, T-rings, elastomers, etc.) may be positioned around the plunger 420 to create a fluid seal between the plunger 420 and the inner surface of the mandrel 410. In at least some embodiments, the plunger 420 may act as a hydraulic piston that is moved by fluid or a pressure differential within the fluid (e.g., a larger fluid pressure in the inner flow channel 132 may move the plunger 420 in one direction and a reduced fluid pressure relative to the wellbore annulus may move the plunger 420 in
an opposing direction). The spring 426 may assist or resist movement in one or each direction that the plunger 420 may move.

[0051] One embodiment of the operation of the downhole tool 100 of FIGS. 1 and 2 is described with reference to FIGS. 5-11. More particularly, FIGS. 5-8 are directed to the activation of a downhole tool (i.e., moving cutter blocks from the retracted position to the expanded position), and FIGS. 9-11 are directed to the deactivation of a downhole tool (i.e., moving the cutter blocks from the expanded position back to the retracted position).

[0052] FIG. 5 is a cross-sectional view of the control module 300 of FIG. 3 in one stage of operation. In particular, in the stage shown in FIG. 6, an obstruction device or impediment (e.g., first ball 322) may be received in the activation sleeve 310, according to one or more embodiments disclosed. A downhole tool that includes the control module 300 (e.g., downhole tool 100 of FIG. 1) may be run into a wellbore on a drill pipe, a wireline, a coiled tubing, or the like. The downhole tool may include cutter blocks (e.g., cutter blocks 120) in a retracted position as the downhole tool is run into the wellbore. When the downhole tool is in the desired position in the wellbore, the first ball 322 may be dropped into the wellbore from a surface location. The first ball 322 may flow into the axial bore 312 of the downhole tool and engage the seat 316 of the activation sleeve 310.

[0053] FIG. 6 is a cross-sectional view of the control module 300 of FIG. 5, and further shows the activation sleeve 310 moving from a first position to a second position, according to one or more embodiments of the present disclosure. In particular, when the first ball 322 is on the seat 316 of the activation sleeve 310, the first ball 322 may restrict or even prevent fluid from flowing through the axial bore 312, past the first ball 322. This may cause the pressure of the fluid to increase above the first ball 322. The increasing pressure may also exert and increasingly large downward force (e.g., left to right, as shown in FIG. 6) on the first ball 322 and the seat 316 of the activation sleeve 310. As used herein, “above” refers to a position that is closer to the first or upper end portion 112 of the body 110 and/or a position that is closer to the origination point of the wellbore in the Earth’s surface. As used herein, “downward” refers to a direction toward the second or lower end portion 114 of the body 110 and/or a direction away from the origination point of the wellbore in the Earth’s surface.

[0054] The downward force may be increased by increasing the flow rate or pressure of the fluid that is pumped into the axial bore 312. The shear pins 352 may be rated to withstand a threshold or predetermined amount of force. When the downward force reaches the predetermined or threshold amount, the shear pins 352 coupling the activation sleeve 310 to the cap 350 may shear, allowing the activation sleeve 310 to move from the first axial position in the body 110 (see FIG. 5) to a second axial position in the body 110 (see FIG. 6). The movement to the second axial position may be in the downward direction (e.g., left to right as shown in FIG. 6). In some embodiments, the activation sleeve 310 may come to rest in the second axial position when the activation sleeve 310 contacts a shoulder, stop, or other component in the body 110, or coupled to the body 110 (e.g., the valve 360).

[0055] FIG. 7 is a cross-sectional view of the control module 300 and shows an embodiment in which the first ball 322 is able to pass through the seat 316 and through the activation sleeve 310. In such an embodiment, the activation sleeve 310 may move from the second axial position (see FIG. 6) to a third axial position (see FIG. 7). The pressure of the fluid above the first ball 322 may continue to increase even when the activation sleeve 310 is in the second axial position. When the force exerted on the first ball 322 and the seat 316 reaches a second threshold or predetermined amount, the first ball 322, the seat 316 of the activation sleeve 310, or both, may deform to allow the first ball 322 to pass through the seat 316. The threshold or predetermined amount that causes deformation of the first ball 322, the seat 316, or both, may be greater than the threshold or predetermined amount that causes the shear pins 352 to shear. When the first ball 322 passes through the activation sleeve 310 and/or the seat 316, the first ball 322 may then travel within the axial bore 312 to a position that is below or downstream of the openings 314 in the activation sleeve 310, as shown in FIG. 7. This may reestablish fluid flow from the axial bore 312, through the openings 314 in the activation sleeve 310, to the outer flow channels 140 in the body 110.

[0056] In addition, once the first ball 322 passes through the seat 316 and/or the activation sleeve 310, the biasing force exerted by the activation spring 320 on the activation sleeve 310 in the upward direction (e.g., right to left, as shown in FIG. 7) may exceed the force exerted on the activation sleeve 310 in the downward direction by the fluid in the axial bore 312. This may cause the activation sleeve 310 to move in the upward direction from the second axial position in the body 110 to a third axial position in the body 110, as shown in FIG. 7. The activation sleeve 310 may come to rest in the third axial position when the activation sleeve 310 contacts the deactivation sleeve 330. In some embodiments, the third axial position may be upward (e.g., left) of the first and/or second axial position of the activation sleeve 310.

[0057] The activation sleeve 310 may no longer restrict or prevent fluid flow through the openings 362 in the valve 360 when in the third axial position. More particularly, when in the third axial position, the activation sleeve 310 may be axially offset from the openings 362 in the valve 360, and fluid may flow from the axial bore 312, radially outwardly through the openings 314 in the activation sleeve 310, and radially inwardly into the inner flow channel 132 through the openings 362 in the valve 360, as shown by arrows 366. As shown in FIG. 7, this may allow the fluid to flow around the first ball 322 and the portion of the activation sleeve 310 where the first ball 322 is located.

[0058] FIG. 8 is a cross-sectional view of the activation module 400, and illustrates an example embodiment in which the plunger 420 moves to a position that is axially offset from one or more openings 412 formed radially through the mandrel 410. As discussed herein with respect to FIGS. 5 and 6, when the activation sleeve 310 is in the first and/or second axial position, the plunger 420 may be in a first axial position that restricts or even prevents fluid from flowing from the outer flow channels 140, through the openings 412, and into the chamber 414. When the activation sleeve 310 moves to the third axial position (see FIG. 7), however, fluid may flow into and through the inner flow channel 132 toward the plunger 420. This may cause the pressure of the fluid on the first side 422 of the plunger 420 to increase, thereby increasing a downward force (e.g., left to right, as shown in FIG. 8) generated by the fluid on the plunger 420. The downward force may be increased by increasing the flow rate or pressure of the fluid that is pumped into the wellbore (e.g., from the surface). As the pressure of the fluid communicates with the second
side 424 of the plunger 420 from the annulus may remain substantially constant, the pressure differential across the plunger 420 may increase.

[0059] When the downward force exerted on the plunger 420 due to the pressure differential becomes greater than the upward force exerted on the plunger 420 by the spring 426, the plunger 420 may move from the first axial position (see FIG. 4) to a second axial position (see FIG. 8). When the plunger 420 is in the second axial position, the plunger 420 may allow fluid to flow from the outer flow channels 140 to the chamber 414. More particularly, in the second axial position, the plunger 420 may be axially offset from the openings 412 in the mandrel 410 to allow fluid to flow from the outer flow channels 140, through the openings 412 in the mandrel 410, and into the chamber 414, as shown by arrows 428.

[0060] Once the fluid is allowed to flow into the chamber 414, the pressure of the fluid may exert a force on the cutter blocks (e.g., cutter blocks 120 of FIG. 1) through a drive ring, piston, or other mechanism. The force may cause the cutter blocks to move from the retracted position to the expanded position. The downhole tool may be rotated and/or lowered in the wellbore so that the cutter blocks may increase the diameter of the wellbore while in the expanded position.

[0061] FIG. 9 is a cross-sectional view of the control module 300 showing a second ball 342 being received by a deactivation sleeve 330, according to one or more embodiments disclosed. When the operator is ready to deactivate the downhole tool, a second ball 342 may be dropped into the wellbore from the surface location. In some embodiments, the second ball 342 may have a greater diameter than the first ball 322, which may enable the second ball 342 to come to rest on the seat 336 of the deactivation sleeve 330. The seat 336 may also have a larger diameter than the seat 316 and/or the first ball 322 to allow the first ball 322 to pass through the seat 336 as described herein.

[0062] FIG. 10 is a cross-sectional view of the control module 300, and shows an embodiment in which the deactivation sleeve 330 moves from a first axial position to a second axial position. In such an embodiment, the second ball 342 may pass through the deactivation sleeve 330 and be received in the activation sleeve 310. The engagement between the second ball 342 and the seat 336 of the deactivation sleeve 330 may restrict or even prevent fluid from flowing through the axial bore 312 past the second ball 342 and the seat 336. This may cause the pressure of the fluid to increase above the second ball 342, thereby causing an increase in a downward force (e.g., left to right, as shown in FIG. 10) exerted by the fluid on the second ball 342 and the seat 336 of the deactivation sleeve 330. The downward force may be increased by increasing the flow rate or pressure of the fluid that is pumped into the axial bore 312. When the force reaches a threshold or predetermined amount corresponding to the allowable force supported by the shear pins 354, the shear pins 354 coupling the deactivation sleeve 330 to the cap 350 may shear.

[0063] Once the shear pins 354 shear, the deactivation sleeve 330 may move from the first axial position in the body 110 (see FIG. 9) to a second axial position in the body 110 (see FIG. 10). The movement to the second axial position may be in the downward direction (e.g., left to right, as shown in FIG. 10) and may be in response to the force exerted by the fluid on the second ball 342 and the seat 336 of the deactivation sleeve 330, the expansion of the deactivation spring 340, or a combination thereof. The deactivation sleeve 330 may come to rest in the second axial position when the activation sleeve 310 contacts a shoulder or other component (e.g., valve 360) in or coupled to the body 110.

[0064] In at least one embodiment, the deactivation sleeve 330 may be in contact with the activation sleeve 310, and the movement of the deactivation sleeve 330 from the first axial position to the second axial position may cause the activation sleeve 310 to move. For instance, the movement of the deactivation sleeve 330 may cause the activation sleeve 310 to move from its third axial position (see FIG. 9) back to its second axial position (see FIG. 10). When back in the second axial position, the activation sleeve 310 may once again restrict or prevent fluid flow through the openings 362 in the valve 360 and into the inner flow channel 132.

[0065] When the activation sleeve 310 is in the second axial position, pressure of the fluid on the first side 422 of the plunger 420 may decrease, which may also decrease the downward force exerted on the plunger 420. When the downward force exerted on the plunger 420 due to the pressure differential becomes less than the upward force exerted on the plunger 420 by the spring 426, the plunger 420 may move from the second axial position (see FIG. 8) back to the first axial position (see FIG. 4). When the plunger 420 is in the first axial position, the plunger 420 may once again restrict or even prevent fluid flow from flowing from the outer flow channels 140, through the openings 412, and to the chamber 414. When the fluid flow into the chamber 414 is restricted or prevented, the pressure of the fluid in the chamber 414 may decrease, which may cause the force exerted by a drive ring or other component on expandable members (e.g., cutter blocks 120 of FIG. 1) to decrease. This may cause the expandable members to move from an expanded position back to a retracted position.

[0066] When the force exerted on the second ball 342 and the seat 336 of the deactivation sleeve 330 reaches a second threshold or predetermined amount, the second ball 342, the seat 336 of the deactivation sleeve 330, or both, may deform to allow the second ball 342 to pass through the seat 336 of the deactivation sleeve 330. The second ball 342 may then be received in the seat 316 of the activation sleeve 310. In some embodiments, the second threshold or predetermined amount that deforms the second ball 342, the seat 336, or both, may be greater than the threshold or predetermined amount that causes the shear pins 354 to shear.

[0067] FIG. 11 is a cross-sectional view of the control module 300 showing the second ball 342 passing through the seat 316 of the activation sleeve 310, according to one or more embodiments of the present disclosure. As the pressure above the second ball 342 continues to build while the second ball 342 is in the position shown in FIG. 10, the force on the second ball 342 in the downward direction may continue to increase. When the force exerted on the second ball 342 and the seat 316 of the activation sleeve 310 reaches a third threshold or predetermined amount that may be even greater than the amount that causes the second ball 342, the seat 336, or both, to deform, the second ball 342 may pass through the seat 316 of the activation sleeve 310. This may be accomplished by deforming the second ball 342, the seat 316 of the activation sleeve 310, or both. The second ball 342 may then travel within the axial bore 312 to a position that is below or downhole of the openings 314 in the activation sleeve 310. This may reestablish fluid flow from the axial bore 312, through the openings 314 in the activation sleeve 310, and to the outer flow channels 140 in the body 110.

[0068] As discussed herein, the spring constant of the deactivation spring 340 may be greater than the spring constant of
the activation spring 320, in some embodiments. In some embodiments, the deactivation sleeve 340 may be able to hold the deactivation sleeve 330 and the activation sleeve 310 in their second axial positions, as shown in FIG. 11. This, in turn, may cause the plunger 420 to continue to be axially aligned with the openings 412 in the mandrel 410. As a result, even though fluid flow may be reestablished from the axial bore 312 to the outer flow channels 140, the plunger 420 may still restrict or even prevent fluid flow from the outer flow channels 140, through the openings 314, and into the chamber 414. Thus, the cutter blocks or other expandable elements may remain in a retracted position.

[0069] Turning now to FIGS. 12 to 22, another example embodiment of a downhole tool 500 is shown in additional detail. The downhole tool 500 may operate in a manner similar to the downhole tool 100 of FIG. 1. Accordingly, certain aspects of the description herein related to the downhole tool 100 should be understood to apply equally to the downhole tool 500. Nevertheless, there may be some structural and/or operational differences between the downhole tools 100 and 500, as highlighted by the description which follows.

[0070] FIG. 12 is a cross-sectional view of an illustrative downhole tool 500, according to one or more embodiments of the present disclosure. The downhole tool 500 may be or include any of various tools, including, for example, an underreamer, pipe cutter, section mill, bypass valve, anchor, measuring-while-drilling (“MWD”) tool, logging-while-drilling (“LWD”) tool, bridge plug, packer, sidetracking system, other tools, or any combination of the foregoing.

[0071] The downhole tool 500 may include one or more devices, tools, or other components that are configured to be activated. When activated the components may transition or otherwise move from a first position to a second position. As shown in FIG. 12, for instance, the movable components may be or include one or more cutter blocks 520 that are movably coupled to a body 510. The cutter blocks 520 may be activated from a first or retracted position (as shown in FIG. 12) to a second or expanded position. When the cutter blocks 520 are in the retracted position, the cutter blocks 520 may be folded or withdrawn into corresponding recesses 521 in the body 510.

[0072] When the cutter blocks 520 are activated from the retracted position to the expanded position, the cutter blocks 520 may pivot and/or translate to move radially (and potentially axially). For instance, the cutter blocks 520 may move axially toward a first end portion 512 of the body 510 while moving radially outwardly. In some embodiments, an expanded radius of the cutter blocks 520 may be between 102% and 150% of a body radius, or retracted radius, shown as radius 518 in FIG. 13. In other embodiments, the expanded radius may be less than 102% or greater than 150% of the body radius.

[0073] According to some embodiments of the present disclosure, the downhole tool 500 may include a control module 700 and an activation module 800. Example embodiments of a control module 700 and an activation module 800 are discussed in greater detail herein. In some embodiments, the control module 700 may control flow of fluid through flow channels 540 while the activation module 800 may activate the cutter blocks 520. Operation of the control module 700 and the activation module 800 may be linked. In some embodiments, the control module 700 may be replaced with the control module 300 described herein and/or the activation module 800 may be replaced with the activation module 400 described herein.

[0074] FIG. 13 is a cross-sectional view of the downhole tool 500 through line 13-13 in FIG. 12, according to one or more embodiments of the present disclosure. FIG. 13 shows three (3) cutter blocks 520 that are circumferentially offset from one another and in a retracted position relative to the body 510. In some embodiments, a first or “outer” rod 530 may extend axially through at least a portion of the body 510. The outer rod 530 may be positioned radially inward from the cutter blocks 520, and in some embodiments may serve as a support structure for the body 510. The outer rod 530 may be stationary with respect to the body 510. In some embodiments, the outer rod 530 may be coaxial with, or parallel to, a central longitudinal axis of the body 510.

[0075] In some embodiments, a second or “inner” rod 532 may also extend axially through at least a portion of the body 510. As shown in FIG. 13, the inner rod 532 may be positioned within the outer rod 530, although the inner rod 532 may be external to the outer rod 530 in other embodiments (e.g., side-by-side). The inner rod 532 may be coupled to the control module 700 and the activation module 800 (see FIG. 12) or be configured to move axially within or relative to the outer rod 530 and/or the body 510. Some example embodiments of an inner rod 532 and an outer rod 530 are described herein.

[0076] A central bore and/or one or more other flow channels 540 may extend axially through the body 510. In some embodiments, the one or more flow channels 540 may extend along a bore aligned with a central longitudinal axis of the body 510. As discussed herein, however, some embodiments contemplate the use of cutter blocks 520 that may obstruct such a bore. In such an embodiment, and as shown in FIG. 13, the flow channels 540 may be positioned radially outward from the outer and/or inner rods 530, 532.

[0077] FIG. 14 is a cross-sectional view of an example embodiment of a control module 700 of a downhole tool 500. The control module 700 may include a first or “activation” sleeve 710. In some embodiments, the activation sleeve 710 may be located fully or partially within the body 510. Optionally, the activation sleeve 710 may be coupled to a first end portion of the inner rod 532. In some embodiments, the activation sleeve 710 and the inner rod 532 may move together in an axial direction within the body 510.

[0078] The activation sleeve 710 may have an axial bore 712 extending at least partially therethrough. The activation sleeve 710 may also have one or more openings 714 formed radially therethrough. The openings 714 may selectively provide a path of fluid communication from the axial bore 712 to the flow channels 540 in the body 510.

[0079] FIG. 15 is a cross-sectional view of the activation module 800 of the downhole tool 500, according to one or more embodiments of the present disclosure. The activation module 800 may include a mandrel 810 located within the body 510. The mandrel 810 may have an annular configuration and may have one or more openings 812 formed radially therethrough. The openings 812 may provide a path of fluid communication from the flow channels 540 in the body 510 to a chamber 814 in the body 510.

[0080] A plunger 820 may be positioned inside the body 510, and potentially within the mandrel 810. The plunger 820 may be coupled to a second end portion of the inner rod 532, and the inner rod 532 and the plunger 820 may move together
axially within the body 510. As shown in FIG. 15, the plunger 820 may be in a first axial position that may obstruct, and potentially prevent, fluid from flowing from the flow channels 540 to the chamber 814. More particularly, the plunger 820 may restrict or even prevent fluid from flowing from the flow channels 540, through the openings 812 in the mandrel 810, and to the chamber 814 by being axially aligned with, and obstructing, the openings 812 in the mandrel 810. One or more seals 816 (e.g., O-rings, C-rings, T-rings, elastomers, etc.) may be positioned around the plunger 820 to create a fluid seal between the plunger 820 and the inner surface of the mandrel 810. In at least some embodiments, the plunger 820 may act as a mechanical piston that is moved by the inner rod 532.

[0081] An example embodiment of the operation of the downhole tool 500 of FIGS. 12 and 13 is further described with reference to FIGS. 16-22. More particularly, FIGS. 16-19 are directed to the activation of a downhole tool (e.g., moving expandable components from retracted to expanded positions), and FIGS. 20-22 are directed to the deactivation of a downhole tool (e.g., moving expandable components from an expanded position to a retracted position).

[0082] FIG. 16 is a cross-sectional view of the control module 700 of FIG. 14 in one stage of operation. In particular, in the stage shown in FIG. 17, an obstruction device or impend-ment (e.g., first ball 722) may be received in the activation sleeve 710, according to one or more embodiments disclosed. A downhole tool that includes the control module 700 may be run into a wellbore on a drill pipe, coiled tubing, or the like. The downhole tool may include expandable components or members (e.g., cutter blocks 520) in a retracted position as the downhole tool is run into the wellbore. When the downhole tool is in the desired position in the wellbore, the first ball 722 may be dropped into the wellbore from a surface location. The first ball 722 may flow into the axial bore 712 of the downhole tool and engage the seat 716 of the activation sleeve 710.

[0083] FIG. 17 is a cross-sectional view of the control module 700 of FIG. 16, and further shows the activation sleeve 710 moving from a first axial position to a second axial position, according to one or more embodiments of the present disclosure. In particular, when the first ball 722 is on the seat 716 of the activation sleeve 710, the first ball 722 may restrict or even prevent fluid from flowing past the first ball 722. This may cause the pressure of the fluid to increase above the first ball 722. The increasing pressure may also exert an increasingly large downward force on the first ball 722 and the seat 716 of the activation sleeve 710. When the downward force reaches a predetermined or threshold amount, one or more shear pins 752 coupled to the activation sleeve 710 may shear, allowing the activation sleeve 710 to move from the first axial position in the body 510 (see FIG. 16) to a second axial position in the body 510 (see FIG. 17). In some embodiments, the activation sleeve 710 may come to rest in the second axial position when the activation sleeve 710 contacts a shoulder, stop, or other component in the body 510, or coupled to the body 510 (e.g., stop 760).

[0084] FIG. 18 is a cross-sectional view of the control module 700 and shows an embodiment in which the first ball 722 is able to pass through the seat 716 and through the activation sleeve 710. In such an embodiment, the activation sleeve 710 may move from the second axial position (see FIG. 17) to a third axial position (see FIG. 18). When the force exerted on the first ball 722 and the seat 716 reaches a second threshold or predetermined amount, the first ball 722, the seat 716 of the activation sleeve 710, or both, may deform to allow the first ball 722 to pass through the seat 716. The first ball 722 may then travel downhole within the axial bore 712. This may reestablish fluid flow from the axial bore 712, through the openings 714 in the activation sleeve 710, to the flow channels 540 in the body 510.

[0085] FIG. 19 is a cross-sectional view of the activation module 800, and illustrates an example embodiment in which the plunger 820 moves from an axial position in which the plunger is axially aligned with the openings 812 in the mandrel 810 (see FIG. 15) to an axial position that is axially offset from the openings 812 in the mandrel 810. As discussed herein, the inner rod 532 may be coupled to and move with the activation sleeve 710. The plunger 820 may be coupled to or otherwise move with the inner rod 532. Thus, the plunger 820 may move axially within the mandrel 810 in response to the axial movement of the activation sleeve 710.

[0086] As discussed herein, when the activation sleeve 710 is in the first and/or second axial position, (see FIGS. 16 and 17, respectively), the plunger 820 may also be in corresponding first and second axial positions, and in each may restrict, and potentially prevent, fluid from flowing from the flow channels 540, through the openings 812, and to the chamber 814. When the activation sleeve 710 moves to the third axial position (see FIG. 18), however, the plunger 820 may move to a corresponding third axial position that allows fluid to flow from the flow channels 540 and to the chamber 814. More particularly, the plunger 820 may move to a position that is axially offset from the openings 812 in the mandrel 810 to allow fluid to flow from the flow channels 540, through the openings 812 in the mandrel 810, through one or more openings 822 formed axially through the plunger 820, and into the chamber 814, as shown by arrows 824. Pressure of fluid in the chamber 814 may exert a force to expand expandable components such as cutter blocks 520 of FIG. 12 through a drive ring, piston, direct fluid pressure, or other mechanisms.

[0087] FIG. 20 is a cross-sectional view of the control module 700 showing a second ball 742 being received by a deacti-vation sleeve 730, according to one or more embodiments disclosed. When the operator is ready to deactivate the down-hole tool, a second ball 742 may be dropped into the wellbore from the surface location, or otherwise released within the wellbore. In some embodiments, the second ball 742 may have a different diameter than the first ball 722, which may enable the second ball 742 to come to rest on the seat 736 of the deactivation sleeve 730. The seat 736 may also have a different diameter than the seat 716 and/or the first ball 722 to allow the first ball 722 to pass through the seat 736 as described herein.

[0088] FIG. 21 is a cross-sectional view of the control module 700, and shows an embodiment in which the deactivation sleeve 730 moves from a first axial position to a second axial position. In such an embodiment, the second ball 742 may pass through the deactivation sleeve 730 and be received in the seat 716 of the activation sleeve 710. The engagement between the second ball 742 and the seat 736 of the deactivation sleeve 730 may restrict or even prevent fluid from flowing through the axial bore 712 past the second ball 742 and the seat 736. Fluid pressure may shear the shear pins 754, allowing the deactivation sleeve 730 to move from the first axial position in the body 510 (see FIG. 20) to a second axial position in the body 510 (see FIG. 21). Optionally, the deactivation sleeve 730 may come to rest in the second axial
position when the activation sleeve 710 contacts a shoulder in the body 510 or a component (e.g., stop 760) in or coupled to the body 510.

[0089] In at least one embodiment, the inner rod 532 and the plunger 820 may move with the activation sleeve 710. As discussed herein with reference to FIG. 15, the plunger 820 may restrict, and potentially prevent, fluid flow from the flow channels 540 in the body 510 to the chamber 814 when the activation sleeve 710 is in its second axial position. When the fluid flow into the chamber 814 is limited, prevented, or otherwise restricted, the pressure of the fluid in the chamber 814 may decrease, which may allow or cause expandable members to move from the expanded position back to the retracted position.

[0090] FIG. 22 is a cross-sectional view of the control module 700 showing the second ball 742 passing through the activation sleeve 710, according to one or more embodiments of the present disclosure. As the pressure above the second ball 742 continues to build while the second ball 742 is in the position shown in FIG. 21, the force on the second ball 742 and the seat 716 of the activation sleeve 710 may reach a third threshold or predetermined amount that causes the second ball 742, the seat 736, or both, to deform. The second ball 742 may then pass through the seat 716 of the activation sleeve 710. As discussed herein, the spring constant of a deactivation spring 740 may be greater than the spring constant of an activation spring 720. The deactivation spring 740 may be able to hold the deactivation sleeve 730 and the activation sleeve 710 in their second axial positions, as shown in FIG. 22. This, in turn, may hold the plunger 820 in its second axial position. As a result, even though fluid flow may be reestablished from the axial bore 712 to the flow channels 540, the plunger 820 may still restrict or even prevent fluid flow from the flow channels 540, through the openings 714, and into the chamber 814. Thus, the cutter blocks or other expandable elements may remain in a retracted position.

[0091] In some embodiments, a downhole tool (e.g., downhole tool 500) may be activated by running the downhole tool into a wellbore. The downhole tool may include a body having a flow channel, and may also include a rod, a first sleeve, a plunger, and an expandable component. The flow channel may extend axially through at least a portion of the body. The rod may extend axially through at least a portion of the body. In some embodiments, the rod may be radially inward from the flow channel. The first sleeve may be within the body and coupled to a first end portion of the rod, while the plunger may be coupled to a second end portion of the rod. The expandable component, which may include a cutter block or other cutting tool, may be movable coupled to the body. A first ball may be introduced into the downhole tool (e.g., from a surface or downhole location) and passed to a seat of the first sleeve in the body. Seating of the first ball may cause the first sleeve, the rod, and the plunger to move from a first axial position to a second axial position.

[0092] In some embodiments, the plunger may be arranged, designed, or otherwise configured to restrict fluid flow from the flow channel to a chamber in the body when the plunger is in the first axial position, the second axial position, or both. Optionally, activating a downhole tool may include providing fluid to the wellbore and thereby deforming the first ball, the seat of the first sleeve, or a combination thereof. In response to such deformation, the first ball may be moved past the first sleeve. A spring, piston, or other biasing member may also move the first sleeve, the rod, and the plunger from the second axial position to a third axial position at least partially in response to the first ball moving past the seat of the first sleeve. The first sleeve may include opening formed radially therethrough that provides a path of fluid communication from an axial bore to the flow channel.

[0093] In some embodiments, a plunger may be moved to a third axial position that allows fluid to flow from the flow channel to the chamber in the body. The expandable component may be moved from a retracted position to an expanded position at least partially in response to fluid flow from the flow channel into the chamber in the body. A second ball may also be introduced into the wellbore or downhole tool (e.g., from a surface or downhole location) and seated on a seat of a second sleeve in the body. Receiving the second ball on the seat of the second sleeve, and potentially fluid pressure behind the second ball, may be used to return the first sleeve, the rod, and the plunger from the third axial position back to the second axial position.

[0094] In the description herein, various relational terms are provided to facilitate an understanding of various aspects of some embodiments of the present disclosure. Relational terms such as “bottom,” “below,” “top,” “above,” “back,” “front,” “left,” “right,” “rear,” “forward,” “up,” “down,” “horizontal,” “vertical,” “clockwise,” “counterclockwise,” “upper,” “lower,” “uphole,” “downhole,” and the like, may be used to describe various components, including their operation and/or illustrated position relative to one or more other components. Relational terms do not indicate a particular orientation or spatial relationship for each embodiment or within the scope of the description or claims. For example, a component of a bottomhole assembly that is described as “below” another component may be further from the surface while within a vertical wellbore, but may have a different orientation during assembly, when removed from the wellbore, or in a deviated borehole. Accordingly, relational descriptions are intended solely for convenience in facilitating reference to various components, but such relational aspects may be reversed, flipped, rotated, moved in space, placed in a diagonal orientation or position, placed horizontally or vertically, or similarly modified. Certain descriptions or designations of components as “first,” “second,” “third,” and the like may also be used to differentiate between identical components or between components which are similar in use, structure, or operation. Such language is not intended to limit a component to a singular designation. As such, a component referenced in the specification as the “first” component may be the same or different than a component that is referenced in the claims as a “first” component.

[0095] Furthermore, while the description or claims may refer to an additional or other element, feature, aspect, or the like, it does not preclude there being a single element, or more than one, of the additional element. Where the claims or description refer to “a” or “an” element, such reference is not be construed that there is just one of that element, but is instead to be inclusive of other components and understood as “at least one” of the element. It is to be understood that where the specification states that a component, feature, structure, function, or characteristic “may,” “might,” “can,” or “could” be included, that particular component, feature, structure, or characteristic is provided in some embodiments, but is optional for other embodiments of the present disclosure. The terms “couple,” “coupled,” “connect,” “connection,” “connected,” “in connection with,” and “connecting” refer to “in direct connection with,” or in con-
nection with via one or more intermediate elements or members.” Components that are “integral” or “integrially” formed include components made from the same piece of material, or sets of materials, such as by being commonly molded or cast from the same material, or commonly machined from the same piece of material stock. Components that are “integral” should also be understood to be “coupled” together.

Although various example embodiments have been described in detail herein, those skilled in the art will readily appreciate in view of the present disclosure that many modifications are possible in the example embodiments without materially departing from the present disclosure. Accordingly, any such modifications are intended to be included in the scope of this disclosure. Likewise, while the disclosure herein contains many specifics, these specifics should not be construed as limiting the scope of the disclosure or of any of the appended claims, but merely as providing information pertinent to one or more specific embodiments that may fall within the scope of the disclosure and the appended claims. Any described features from the various embodiments disclosed may be employed in combination.

A person having ordinary skill in the art should realize in view of the present disclosure that equivalent constructions do not depart from the spirit and scope of the present disclosure, and that various changes, substitutions, and alterations may be made to embodiments disclosed herein without departing from the spirit and scope of the present disclosure. Equivalent constructions, including functional “means-plus-function” clauses are intended to cover the structures described herein as performing the recited function, including both structural equivalents that operate in the same manner, and equivalent structures that provide the same function. It is the express intention of the applicant not to invoke means-plus-function or other functional claiming for any claim except for those in which the words “means for” appear together with an associated function. Each addition, deletion, and modification to the embodiments that falls within the meaning and scope of the claims is to be embraced by the claims.

While embodiments disclosed herein may be used in oil, gas, or other hydrocarbon exploration or production environments, such environments are merely illustrative. Systems, tools, assemblies, methods, underreamers, activation systems, and other components which would be appreciated in view of the disclosure herein, may be used in other applications and environments. In other embodiments, reamers, downhole tools, methods for activating a downhole tool, or other embodiments discussed herein, or which would be appreciated in view of the disclosure herein, may be used outside of a downhole environment, including in connection with other systems, including within automotive, aquatic, aerospace, hydroelectric, manufacturing, other industries, or even in other downhole environments. The terms “well,” “wellbore,” “borehole,” and the like are therefore also not intended to limit embodiments of the present disclosure to a particular industry. A wellbore or borehole may, for instance, be used for oil and gas production and exploration, water production and exploration, mining, utility line placement, or myriad other applications.

Certain embodiments and features may have been described using a set of numerical values that may provide lower and upper limits. It should be appreciated that ranges including the combination of any two values are contemplated, as are ranges with a single upper limit or a single lower limit. A value may also be provided in lieu of a range. All numbers, percentages, ratios, measurements, or other values stated herein (including a single value in lieu of a range) are intended to include not only the stated value, but also other values that are about or approximately the stated value, as would be appreciated by one of ordinary skill in the art encompassed by embodiments of the present disclosure. A stated value should therefore be interpreted broadly enough to encompass values that are at least close enough to the stated value to perform a desired function or achieve a desired result. The stated values include at least experimental error and variations that would be expected by a person having ordinary skill in the art, as well as the variation to be expected in a suitable manufacturing or production process. A value that is about or approximately the stated value and is therefore encompassed by the stated value may further include values that are within 5%, within 1%, within 0.1%, or within 0.01% of a stated value.

The Abstract in this disclosure is provided to allow the reader to quickly ascertain the general nature of some embodiments of the present disclosure. It is submitted with the understanding that it will not be used to interpret or limit the scope or meaning of the claims.

What is claimed is:

1. An activation system, comprising:
   a body having an outer flow channel and a chamber therein;
   a valve within the body, the valve including an inner flow channel therein, the inner flow channel being positioned radially inward from the outer flow channel;
   a plunger configured to move at least partially in response to fluid flowing through the inner flow channel from a first position that restricts fluid flow from the outer flow channel to the chamber in the body to a second position that allows fluid flow from the outer flow channel to the chamber in the body; and
   an expandable component coupled to the body, the expandable component being configured to move radially from a retracted position to an expanded position at least partially in response to fluid flowing into the chamber.

2. The activation system of claim 1, further comprising:
   a first sleeve within the body, the first sleeve being axially movable within the body between:
   a first axial position that restricts fluid flow into the inner flow channel; and
   a second axial position that allows fluid flow into the inner flow channel.

3. The activation system of claim 2, the valve including an opening providing a path of fluid communication to the inner flow channel, the valve being configured to be positioned at least partially within the first sleeve when the first sleeve is in the first axial position such that the first sleeve restricts fluid flow through the opening of the valve.

4. The activation system of claim 2, further comprising:
   a second sleeve within the body, the first sleeve being biased in a first axial direction, and the second sleeve being biased in a second axial direction opposed to the first axial direction.

5. The activation system of claim 1, further comprising:
   a mandrel coupled to the body, the mandrel including an opening that provides a path of fluid communication from the outer flow channel to the chamber in the body, the chamber being radially outward from the outer flow channel.
6. The activation system of claim 1, the plunger being biased toward the first position.

7. An activation system, comprising:
   a body having a flow channel extending at least partially therethrough;
   a rod axially movable within at least a portion of the body and positioned radially inward from the flow channel; and
   an expandable component movably coupled to the body and positioned radially outward from the rod, the expandable component being configured to move radially from a retracted position to an expanded position at least partially in response to axial movement of the rod.

8. The activation system of claim 7, further comprising:
   a first sleeve within the body, the first sleeve being movable with the rod to selectively provide a path of fluid communication to the flow channel.

9. The activation system of claim 8, further comprising:
   a second sleeve movably positioned within the body, the first and second sleeves being biased to move in opposing axial directions.

10. The activation system of claim 7, further comprising:
    a mandrel within the body, the mandrel including a radial opening providing a path of fluid communication from the flow channel to a chamber in the body, the chamber being positioned radially inward from the flow channel.

11. The activation system of claim 10, further comprising:
    a plunger coupled to the rod and configured to move together with the rod from a first position that restricts fluid flow through the radial opening to the chamber in the body to a second position that allows fluid flow through the opening to the chamber in the body.

12. The activation system of claim 11, the plunger including an axial opening providing a path of fluid communication from the radial opening to the chamber.

13. A method for activating a downhole tool, comprising:
    running a downhole tool into a wellbore, the downhole tool including:
    a body having an outer flow channel;
    a valve within the body, the valve including an inner flow channel positioned radially inward relative to the outer flow channel;
    a first sleeve within the body, the sleeve being coupled to a first seat;
    a plunger within the body and in fluid communication with the inner flow channel; and
    a cutting tool movably coupled to the body;
    introducing a first ball into the downhole tool and causing the first ball to be received by the first seat; and
    supplying fluid to the downhole tool, wherein supplying fluid to the downhole tool includes:
    building fluid pressure behind the first ball;
    passing the first ball past the first seat;
    moving the first sleeve axially within the body from a first position that restricts fluid flow into the inner flow channel to a second position that allows fluid flow into the inner flow channel at least partially in response to passing the first ball past the first seat; and
    moving the plunger from a first position that restricts fluid flow from the outer flow channel to a chamber in the body to a second position that allows fluid flow from the outer flow channel to the chamber in the body at least partially in response to fluid flowing into the inner flow channel.

14. The method of claim 13, wherein supplying fluid to the downhole tool includes moving the cutting tool radially outward from a retracted position to an expanded position at least partially in response to fluid flowing into the chamber.

15. The method of claim 14, wherein building fluid pressure behind the first ball includes deforming at least one of the first ball or the first seat.

16. The method of claim 13, wherein moving the first sleeve axially within the body is performed at least partially in response to a first biasing member biasing the first sleeve toward the second position when the first ball moves past the first seat.

17. The method of claim 13, further comprising:
    introducing a second ball into the downhole tool and causing the second ball to be received by a second seat coupled to a second sleeve within the body; and
    returning the first sleeve to the first position at least partially in response to the second ball being received by the second seat.

18. The method of claim 17, wherein returning the first sleeve to the first position includes using a second biasing member that biases the second sleeve toward the first position when the second ball moves past the second seat.

19. The method of claim 17, the downhole tool further including a cap coupled to the body and radially outward of the first and second sleeves, the cap being coupled to the first and second sleeves by one or more shear elements.

20. The method of claim 13, the first sleeve including an opening providing a path of fluid communication from an axial bore in the body to the inner flow channel, the outer flow channel, or both.