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(54) **Title:** SELECTIVELY ACTIVATED FRICTION REDUCTION TOOL AND METHOD

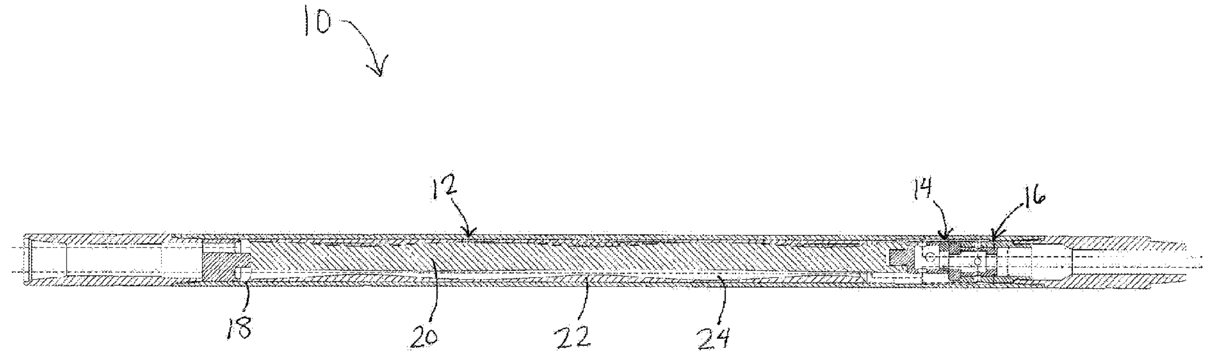

Fig. 1

(57) **Abstract:** A friction reduction tool configured for selective activation downhole in response to a variation in a media flow's operating condition. A valve assembly and an activation assembly are both positioned downstream of a power assembly, which is configured to rotate a rotating valve segment of the valve assembly with media flow through the tool. The activation assembly is configured to transition from a first position to a second position with the media flow operating condition variation. In the first position, the activation assembly provides a bypass flow path around the valve assembly for at least a portion of the media flow, thereby preventing the valve assembly from generating any significant pressure pulse with rotation of the rotating valve segment. In the second position, the bypass flow path is closed such that all or a majority of the media flows through the valve assembly, thereby generating a significant pressure pulse.

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SELECTIVELY ACTIVATED FRICTION REDUCTION TOOL AND METHOD

BACKGROUND OF THE INVENTION

[0001] In the drilling of oil and gas wells, a downhole drilling motor and a drill bit are attached to the end of a drill string. Most downhole drilling motors include a rotor rotating within a stator. The rotation of the rotor provides a vibration to the adjacent drill bit as it cuts through the subterranean formation to drill the wellbore. The drill string slides through the higher portions of the wellbore as the drill bit at the end of the drill string extends the wellbore deeper into the formation. A friction reduction tool is sometimes attached to the drill string a distance above the drill bit (e.g., 800 – 1,500 feet above the drill bit). The friction reduction tool provides vibration to the portions of the drill string above the friction reduction tool, thereby facilitating a smoother movement of the drill string through the wellbore.

[0002] However, continuous operation of the friction reduction tool may not be desirable, such as when the drill bit is drilling vertically from the surface. To address such problems, a selectively activated friction reduction tool may be introduced into the drill string to provide vibration to the drill string upon activation of the friction reduction tool. Such a tool is disclosed herein.

BRIEF DESCRIPTION OF THE DRAWINGS

[0003] Fig. 1 is a cross-sectional view of one embodiment of a friction reduction tool disclosed herein in a stationary mode.

[0004] Fig. 2 is a cross-sectional view of an activation assembly of the friction reduction tool in a first position.

[0005] Fig. 3 is a perspective view of a rotating valve segment of the friction reduction tool.

[0006] Fig. 4 is a perspective view of a stationary valve segment and activation assembly of the friction reduction tool.

[0007] Fig. 5 is a cross-sectional view of the friction reduction tool in a dynamic mode.

[0008] Fig. 6 is a cross-sectional view of the activation assembly in a second position.

[0009] Fig. 7 is a cross-sectional view of the friction reduction tool disposed within a wellbore.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0010] A friction reduction tool of the present disclosure is configured to be selectively activated downhole in response to a variation in an operating condition of a media flow through the tool. The friction reduction tool may include a valve assembly positioned downstream of a power assembly. The power assembly may rotate a segment of the valve assembly in response to a flow of a media through tool. In a stationary mode, media flow through the valve assembly may generate no significant pressure pulse or water hammer. In a dynamic mode, media flow through the valve assembly may generate a pressure pulse or water hammer in a media flow column that is transmitted to a coiled tubing line or a shock sub of a drill string to which the friction reduction tool is attached.

[0011] In some embodiments, the friction reduction tool may include an activation assembly. When the activation assembly is in a first position, the friction reduction tool operates in the stationary mode. When the activation assembly is in a second position, the friction reduction tool operates in the dynamic mode. The activation assembly may transition from the first position to the second position in response to certain media operating condition adjustments or variations, such as an increased media flow rate or an increased media density. In the first position, the activation assembly may provide a bypass flow path around the valve assembly for at least a portion of the media flowing through the tool. The flow of media through the bypass flow path limits or minimizes the pressure pulse generated by the valve assembly when the activation assembly is in the first position, which places the friction reduction tool in the stationary mode. In the second position, the activation assembly may discontinue, prevent, or minimize the flow of media through the bypass flow path, which results in all or substantially all of the media flowing through the tool to flow through the valve assembly, which generates pressure pulses and places the friction reduction tool in the dynamic mode.

[0012] In certain embodiments, the activation assembly includes one or more bypass ports that are open in the first position and substantially closed in the second position. For example, an increase in flow rate or density of the media flowing through the tool may cause a sleeve of the activation assembly to slide from a default position to an engaged position, thereby transitioning the activation assembly from the first position to the second position. In some embodiments, the sleeve of the activation assembly may close the one or more bypass ports in the engaged position. The closing of the one or more bypass ports may transition the friction reduction tool from the stationary mode to the dynamic mode.

[0013] Fig. 1 illustrates one embodiment of the selectively activated friction reduction tool of the present disclosure. Friction reduction tool **10** may include power assembly **12**, valve assembly **14**, and activation assembly **16**. Friction reduction tool **10** may also include housing **18** having an inner bore, with power assembly **12**, valve assembly **14**, and activation assembly **16** disposed within the inner bore of housing **18**. Housing **18** may be formed of one or more housing segments, each including an inner bore.

[0014] Power assembly **12** may include any hydraulic motor, or any other motor driven by a media, which is configured to rotate a rotating valve segment of valve assembly **14**. In some embodiments, power assembly **12** may include a positive displacement motor, such as a Moineau motor or any progressive cavity positive displacement pump. In other embodiments, power assembly **12** may include a vane motor. In still other embodiments, power assembly **12** may include a turbine. As used herein, “media” means any liquid or gas, or any mixture, solution, or other combination of one or more liquids and/or one or more gases. Non-limiting examples of media include water-based drilling fluids, oil-based drilling fluids, compressible fluids, mists, nitrogen gas, and underbalanced mixtures of nitrogen gas in liquids.

[0015] In the illustrated embodiment, power assembly **12** may include a positive displacement motor having rotor **20** and stator **22**. Stator **22** may be secured within the inner bore of housing **18**. Rotor **20** may have no axial bore or central bore running therethrough. In one embodiment, rotor **20** may be a single lobe rotor and stator **22** may be a dual lobe stator. Media flowing through the inner bore of housing **18** flows through cavity **24** between rotor **20** and stator **22**, which causes rotor **20** to rotate within stator **22**. In this way, power assembly **12** includes rotor **20** configured to rotate with the media flow through power assembly **12**.

[0016] Valve assembly **14** may include a rotating valve segment and a stationary valve segment each including at least one passage. The rotating valve segment may be configured to rotate with rotation of rotor **20**, while the stationary valve segment remains fixed (i.e., does not rotate in relation to housing **18**). In an open position, the passage of the rotating valve segment is aligned with the passage of the stationary valve segment to allow media flow through these passages. In a restricted position, the passage of the rotating valve segment is not aligned with the passage in the stationary valve segment (e.g., at least partially unaligned), thereby temporarily restricting any media flow through valve assembly **14**.

[0017] In the embodiment illustrated in Figs. 2 – 4, the rotating valve segment of valve assembly **14** may include adaptor **26** and rotating valve disk **30** disposed within an inner bore of adaptor **26**. A first end of adaptor **26** may be configured for rotational connection to a portion of power assembly **12** to enable power assembly **12** to rotate adaptor **26** and rotating valve disk **30**. For example, the first end of adaptor **26** may be configured for rotational connection to a downstream end of rotor **20** such that rotation of rotor **20** rotates adaptor 26 and rotating valve disk **30**. Adaptor **26** may also include one or more ports **27** configured to allow media flow into the inner bore of adaptor **26** from annular space **36** formed between adaptor **26** and housing **18**. In some embodiments, lateral ports **27** are distributed around the circumference of adaptor 26 at varying axial positions along the length of adaptor **26** as illustrated in Figs. 2 and 3. Rotating valve disk **30** may include one or more passages **34** in fluid communication with the inner bore of adaptor **26**.

[0018] The stationary valve segment may include stationary valve disk **32** that engages rotating valve disk **30**. Stationary valve disk **32** may include one or more passages **40**. Stationary valve disk **32** may be secured directly or indirectly to housing **18** such that stationary valve disk **32** does not rotate in relation to housing **18**. In a non-limiting example shown in the illustrated embodiment, stationary valve disk **32** may be secured at least partially within an inner bore of activation body **28**, which is secured to housing **18** such that activation body **28** and stationary valve disk **32** are prevented from rotating relative to housing **18**. Numerous alternative embodiments in which tool **10** is configured to prevent rotation of stationary valve disk **32** in relation to housing **18** are readily understood by skilled artisans. In this way, a valve flow path may be defined by annular space **36** surrounding adaptor **26**, lateral ports **27** in adaptor **26**, the inner bore of adaptor **26**, passages **34** of rotating valve disk **30**, and passages **40** of stationary valve disk **32**. In the illustrated embodiment, rotor **20** is operatively positioned upstream of valve assembly **14** in which the rotating valve segment is positioned upstream of the stationary valve segment. In other embodiments, the rotating valve segment may be positioned downstream of the stationary valve segment.

[0019] With reference to Fig. 2, rotation of rotor **20** in the illustrated embodiment causes rotation of adaptor **26** and rotating valve disk **30**. Continued flow of media through power assembly **12** causes rotor **20**, adaptor **26**, and rotating valve disk **30** to continue rotating in the same direction; the direction of rotation of rotating valve disk **30** does not change. Rotating valve disk **30** rotates relative to stationary valve disk **32**, which remains fixed and does not rotate relation to housing **18**. The relative rotation of rotating valve disk **30** cycles valve assembly **14** between the open position and the restricted position. In the open position, passages **34** of rotating valve disk **30** are aligned with one or more of passages **40** of stationary valve disk **32**. In the restricted position, passages **34** of rotating valve disk **30** are at least non-aligned with one or more of passages **40** of stationary valve disk **32**. In other words, the valve flow path is open in the open position of the valve assembly **14** and closed in the closed position of valve assembly **14**.

[0020] Figs. 1 and 2 illustrate one embodiment of a first position of activation assembly **16**. In this first position, activation assembly **16** provides a bypass flow path around valve assembly **14** for a portion of a media flowing through friction reduction tool **10**. The remainder of the media may flow through valve assembly **14** while activation assembly **16** is in the first position, which places friction reduction tool **10** in the stationary mode. In this way, activation assembly **16** may provide a partial bypass around valve assembly **14** when in the first position. The bypass flow path may have a greater cross-sectional area than the valve flow path. In some embodiments, a majority of the media flowing through friction reduction tool **10** may bypass valve assembly **14** while tool **10** is in the stationary mode due to the bypass flow path's greater cross-sectional area. In other embodiments, all of the media flowing through friction reduction tool **10** in the stationary mode may bypass valve assembly **14**. In this way, activation assembly **16** may provide a complete bypass when in the first position. As used herein in reference to the bypass flow path, the bypass flow, and/or the bypass, "around" the valve assembly means any flow path that allows fluid to flow downstream beyond the position of the valve assembly within the friction reduction tool without flowing through the valve assembly, including outside of the valve assembly, past the valve assembly, and/or through a separate component that is near the valve assembly.

[0021] With reference to Figs. 2 and 4, the illustrated embodiment of activation assembly **16** may include activation sleeve **48** disposed within an inner bore of activation body **28**. Activation sleeve **48** and activation body **28** may each include one or more lateral bypass ports **50** and **52**, respectively. The bypass flow path may be defined by annular space **38** between activation body **28** and housing **18**, bypass ports **52** of activation body **28**, and bypass ports **50** of activation sleeve **48**. This bypass flow path may have a greater cross-sectional area than the valve flow path in this embodiment. In other embodiments, the bypass flow path may include any other flow path around valve assembly **14**, with or without any bypass ports. For example, the bypass flow path may include an annular space between two components of the activation assembly **16** without any bypass ports. Activation sleeve **48** may further include restricted inner bore section **53** forming shoulder **62** within the inner bore of activation sleeve **48**. Both restricted inner bore section **53** and shoulder **62** may be positioned downstream of bypass ports **50**. Restricted inner bore section **53** may provide the minimum cross-sectional flow area within friction reduction tool **10**. All media flowing through the valve flow path and all media flowing through the bypass flow path are directed to and must flow through restricted inner bore section **53** of activation sleeve **48**. In this way, restricted inner bore section **53** may provide a nozzle through which all media flowing through friction reduction tool **10** must flow.

[0022] Activation assembly **16** may further include one or more shear mechanisms **54**, one or more stop mechanisms **56**, and one or more seals **58**. Each shear mechanism **54** may extend from a lateral bore or recess in activation body **28** into a lateral bore or recess in activation sleeve **48**. With activation assembly **16** in the first position, the shear mechanisms **54** may be disposed upstream, downstream, or at least one upstream and at least one downstream of the bypass ports in activation sleeve **48** and/or the bypass ports in activation body **28**. The shear mechanisms **54** may include shear pins, set screws, O-rings, spring-loaded ball arrangements, or any other mechanisms configured to break or change positions in response to a predefined downstream force in order to allow activation sleeve **48** to slide relative to activation body **28**. Each stop mechanism **56** may extend from a lateral bore or recess in the inner bore of activation body **28**. The stop mechanism **56** may include a ring, an upset, one or more set screws, or any other mechanism configured to limit downstream movement of activation sleeve **48** relative to activation body **28**. The seals **58** may include O-rings or any other seal elements.

[0023] Referring again to Fig. 2, when activation assembly **16** is in the first position, activation sleeve **48** may be positioned within the inner bore of activation body **28** such that bypass ports **50** of activation sleeve **48** are aligned with bypass ports **52** of activation body **28**. In the first position, at least a portion of the media flowing through friction reduction tool **10** may travel from cavity **24** between stator **22** and rotor **20**, through annular space **36** between adaptor **26** and housing **18**, through the bypass flow path described above, and into restricted inner bore section **53** of activation sleeve **48**. In some embodiments, a majority of the media flowing through friction reduction tool **10** may flow through the bypass flow path while activation assembly **16** is in the first position. In other embodiments, all of the media flowing through friction reduction tool **10** may flow through the bypass flow path while activation assembly **16** is in the first stationary position. Seals **58** may prevent or minimize leakage between bypass ports **50** of activation sleeve **48** and bypass ports **52** of activation body **28**.

[0024] Activation assembly **16** may be operatively positioned downstream of rotor **20**. In certain embodiments, activation assembly **16** may be operatively positioned downstream of valve assembly **14**. In the illustrated embodiment, activation assembly **16** may be operatively positioned downstream of both rotor **20** and valve assembly **14**.

[0025] With reference to Figs. 1 and 2, a media flowing into housing **18** of friction reduction tool **10** may flow into cavity **24** between stator **22** and rotor **20**. The media flow through cavity **24** rotates rotor **20**, thereby cycling valve assembly **14** between the open position and the closed position by rotating adaptor **26** and rotating valve disk **30** in relation to stationary valve disk **32**. Media exiting cavity **24** may flow into annular space **36** surrounding adaptor **26**. With activation sleeve **48** in the first position, all or a portion of the media in annular space **36** may flow through the bypass flow path, which includes annular space **38** surrounding activation body **28**, bypass ports **52** of activation body **28**, and bypass ports **50** of activation sleeve **48**, and may continue flowing through the restricted inner bore section **53** of activation sleeve **48**. In this way, at least a portion of the media flowing through tool **10** bypasses around the valve flow path of valve assembly **14**, which includes lateral ports **27** of adaptor **26**, the inner bore of adaptor **26**, passages **34** of rotating valve disk **30**, and passages **40** of stationary valve disk **32**. To the extent that any media flows from annular space **36** into the valve flow path, the continued media flow through open bypass flow path provided by activation assembly **16** in the first position minimizes or completely prevents any pressure pulse or water hammer associated with an interruption of the media flow in the valve flow path when the valve assembly **14** cycles between the open and closed positions. In this way, the bypass flow path provided by activation assembly **16** prevents friction reduction tool **10** from generating any pressure pulses, or minimizes any pressure pulses generated, when media flows through the tool **10** in the stationary mode. In other words, the bypass flow path limits any pressure pulses generated by friction reduction tool **10** in the stationary position to only insignificant pressure pulses. As used herein, an “insignificant” pressure pulse is a pressure pulse of a magnitude that does not cause stretching or retracting of a coiled tubing string, or activation of axial movement of a shock sub or any other part of a drill string, to which friction reduction tool **10** is connected. For example, but not by way of limitation, insignificant pressure pulses generated by friction reduction tool **10** in the stationary mode may be limited to less than 200 psi, or less than 100 psi.

[0026] Activation assembly **16** may be configured to selectively activate friction reduction tool **10** by transitioning friction reduction tool **10** from the stationary mode shown in Figs. 1 and 2 into the dynamic mode shown in Figs. 5 and 6. The selective activation may be effected by transitioning activation assembly **16** from the first position, which is its default position, into a second position. In some embodiments, activation may be reversed by transitioning activation assembly **16** from the second position into the first position. In other embodiments, activation may not be reversible.

[0027] With reference to Fig. 2 and 6, the differential pressure created by media flow through the inner bore **60** of activation sleeve **48**, including through restricted inner bore section **53**, may place a downstream force on shoulder **62** and shoulder **64** of activation sleeve **48**. Shear mechanisms **54** may be configured to retain activation sleeve **48** in the first position shown in Fig. 2 until a predetermined maximum downstream force is placed on shoulders **62** and **64**. Shear mechanisms **54** may be configured to break when the differential pressure imposes a downstream force on shoulders **62** and **64** of activation sleeve **48** exceeding such maximum downstream force. After shear mechanisms **54** break, activation sleeve **48** is permitted to slide within the inner bore of activation body **28**. In the illustrated embodiment, restricted inner bore section **53** and shoulder **62** are integrally formed with the inner bore **60** of activation sleeve **48**. In other embodiments, the restricted inner bore section **53** and shoulder **62** may be provided by a separate component secured to activation sleeve **48** via a connection of sufficient strength to maintain the connection between the separate component and activation sleeve **48** when the downstream force acting on shoulder **62** exceeds the maximum predetermined downstream force that causes shear mechanisms **54** to break, such that the separate component slides with activation sleeve **48** within activation body **28**.

[0028] To selectively activate the friction reduction tool **10**, a user may vary an operating condition of the media flowing through friction reduction tool **10** in order to increase the downstream force on shoulders **62** and **64** of activation sleeve **48** above the predetermined maximum downstream force associated with shear mechanisms **54**. For example, the downstream force on shoulders **62** and **64** and the differential pressure across activation assembly **16** may be increased by increasing the flow rate of the media, by increasing the media's density, or by increasing both the flow rate of the media and the media's density. Each of these operating condition changes cause an increased downstream force to be applied to shoulders **62** and **64**. Once friction reduction tool **10** is activated by breaking shear mechanisms **54**, the continued flow of media through tool **10** may apply a continued downstream force on shoulder **62**, which slides activation sleeve **48** in a downstream direction within the inner bore of activation body **28** until activation sleeve **48** engages stop mechanism **56** in a second position shown in Fig. 6.

[0029] Figs. 5 and 6 illustrate activation assembly **16** in the second position after activation. Transitioning activation assembly **16** into the second position places friction reduction tool **10** in a dynamic mode. In this second position, activation sleeve **48** is positioned within the inner bore of activation body **28** such that bypass ports **50** of activation sleeve **48** are not aligned with bypass ports **52** of activation body **28**. For example, activation sleeve **48** may block bypass ports **52** of activation body **28**. In this way, the bypass flow path may be substantially closed or blocked in the second position of the activation assembly **16**. In this position, seals **58** may prevent or minimize leakage between activation sleeve **48** and bypass ports **52** of activation body **28**. In some embodiments, minimal leakage may be possible through the bypass flow path without affecting the function of friction reduction tool **10**. Stop mechanism **56** may prevent further downhole axial movement of activation sleeve **48** past the second position in which activation sleeve **48** closes the bypass flow path.

[0030] Because the bypass flow path is substantially closed or blocked when activation sleeve **48** is in the second position, all or a majority of the media flowing from cavity **24** into annular space **36** may flow through the valve flow path of valve assembly **14**. In this position, rotation of rotor **20** in response to media flowing through cavity **24** causes valve assembly **14** to cycle between the open position and the closed position. In the open position, the media is allowed to flow through the valve flow path of the valve assembly **14**. However, in the closed position, the unaligned passages **34** and **40** of rotating valve disk **30** and stationary valve disk **32**, respectively, temporarily restricts or limits media flow through the valve flow path. As media flows through the valve flow path of valve assembly **14** with activation assembly **16** in the second position, the cycling between the open position and the closed position of valve assembly **14** generates a significant repeated pressure pulse or water hammer in a media flow column (i.e., the column of media formed within friction reduction tool **10** and the drill string or coiled tubing line to which it is attached). In this way, friction reduction tool **10** generates significant pressure pulses when media flows through the tool **10** in the dynamic mode after activation of activation assembly **16**. As used herein, "significant" pressure pulses or water hammer are pressure pulses or water hammer of sufficient magnitude to stretch or retract a coiled tubing string, or to activate axial movement of a shock sub or another part of a drill string, to which friction reduction tool **10** is connected. For example, but not by way of limitation, significant pressure pulses may be greater than 200 psi, or greater than 300 psi. Whether a pressure pulse of a certain magnitude is significant may depend on the design and configuration of the specific embodiment of the friction reduction tool and the surrounding portions of a coiled tubing string or drill string, such as a shock sub.

[0031] In certain alternate embodiments, the activation sleeve of activation assembly **16** may be disposed around the outer surface of the activation body, with the activation sleeve transitioning from a first position, in which it leaves open the one or more bypass ports of the activation body, to a second position, in which it closes the one or more bypass ports in the activation body.

[0032] Accordingly, with activation assembly **16** in either the first position or the second position (i.e., in either the stationary mode or dynamic mode of friction reduction tool **10**), media flow through cavity **24** rotates rotor **20** and the rotating valve segment of valve assembly **14**. However, the bypass flow path provided by activation assembly **16** in the first position minimizes the amount of, or eliminates, media flow through the valve flow path of valve assembly **14** such that the cycling of valve assembly **14** between the open position and the closed position does not generate any significant pressure pulse in the stationary mode of friction reduction tool **10**. The activation of friction reduction tool **10** into the dynamic mode with the transition of activation assembly **16** into the second position completely closes, or at least substantially closes, the bypass flow path such that all, or substantially all, of the media flows through the valve flow path of valve assembly **14**, thereby generating significant pressure pulses with the cycling of valve assembly **14** between the open position and the closed position.

[0033] Referring now to Fig. 7, friction reduction tool **10a** may be placed into wellbore **64** extending into subterranean formation **65**. Friction reduction tool **10a** may be secured to drill string **66** by threadedly connecting friction reduction tool **10a** to shock assembly **68a** and drill string **66**. Friction reduction tool **10a** may be in the stationary mode when initially deployed. In the stationary mode, at least a portion of a media flowing through friction reduction tool **10a** will flow through the bypass flow path provided by activation assembly **16** of friction reduction tool **10a** in its first position. Accordingly, at least a portion of the media flowing through drill string **66** will bypass valve assembly **14** of friction reduction tool **10a**, thereby allowing only insignificant pressure pulses to be created by the cycling of the valve assembly **14** between the open position and the closed position. In some embodiments, a portion of the media flowing through friction reduction tool **10a** in the stationary mode may flow through valve assembly **14** cycling between the open position and the closed position without generating any significant pressure pulse, i.e., without generating any pressure pulse sufficient to activate adjacent shock assembly **68a**.

[0034] Friction reduction tool **10a** may be selectively activated from the stationary mode to the dynamic mode by increasing the differential pressure across shoulders **62** and **64** of activation sleeve **48** within friction reduction tool **10a**. This selective activation may be accomplished by increasing a flow rate, increasing a density, or increasing both a flow rate and a density of the media flowing through the drill string **66**. For example, a user may increase media density by introducing a higher density media in a pill into the drill string **66** for a certain period of time. The increased media flow rate or increased media density, or both, may increase the pressure drop across activation sleeve **48** and apply an increased downstream force on shoulders **62** and **64** of activation sleeve **48** within friction reduction tool **10a**. The pressure drop increase and downstream force increase created by a particular media condition adjustment is determined by the cross-sectional area of the nozzle provided by the inner bore of the tool's activation sleeve **48** upstream of shoulder **62** and by the reduced inner bore section **53** of the tool's activation sleeve **48** downstream of shoulder **62**. When the increased downstream force exceeds a predefined maximum limit, shear mechanisms **54** within friction reduction tool **10a** may break, thereby allowing activation sleeve **48** to move downstream into the second position in which the bypass flow path is blocked or closed. In this way, friction reduction tool **10a** may be selectively activated from the stationary mode into the dynamic mode. Once the friction reduction tool **10a** is activated and placed in the dynamic mode, all or a majority of the media flowing through friction reduction tool **10a** will flow through valve assembly **14**, thereby generating a significant pressure pulse or water hammer as valve assembly **14** cycles between the open position and closed position. The generated significant pressure pulse or water hammer may be transmitted to drill string **66** (or a coiled tubing string) to which friction reduction tool **10a** is connected. The repeated significant pressure pulse generation may cause axial movement of a portion of shock assembly **68a** (or stretching and retracting in a coiled tubing string to which friction reduction tool 10a is connected), thereby facilitating axial vibration and easing the movement of the drill string through wellbore **64**. The vibration may reduce friction between an outer surface of the drill string and an inner surface of wellbore **64**.

[0035] In certain embodiments, shock assembly **68a** may be connected to an upstream end of friction reduction tool **10a**. When present, the shock assembly **68a** may facilitate relative axial movement of drill string **66** above friction reduction tool **10a** relative to drill string **66** downstream of friction reduction tool **10a** thereby vibrating drill string **66** above friction reduction tool **10a**.

[0036] In certain embodiments, only friction reduction tool **10a** may be deployed within wellbore **64**. In other embodiments, two or more friction reduction tools, such as friction reduction tool **10a** and friction reduction tool **10b**, may be deployed within wellbore **64** as shown in Fig. 7. In some embodiments, both friction reduction tools **10a** and **10b** may be activated from the stationary mode to the dynamic mode with a single adjustment to the media operating condition. This concurrent activation of both friction reduction tools **10a** and **10b** may be accomplished when the nozzle provided by the reduced inner bore section **53** of each tool's activation sleeve **48** have the same cross-sectional area.

[0037] Alternatively, each of friction reduction tools **10a** and **10b** may be configured to be activated by a different value of a media operating condition adjustment by designing the nozzle provided by the restricted inner bore section **53** of each tool's activation sleeve **48** to have a different cross-sectional area. For example, downstream friction reduction tool **10a** may be configured to be activated before upstream friction reduction tool **10b**. In this embodiment, a smaller increase in media flow rate and/or media density will activate friction reduction tool **10a**, while a larger increase in media flow rate and/or media density will be required to activate friction reduction tool **10b**. This configuration may be achieved by sizing the nozzle provided by restricted inner bore section **53** of friction reduction tool **10a**'s activation sleeve 48 to be smaller than the nozzle provided by restricted inner bore section **53** of friction reduction tool **10b**'s activation sleeve **48**. In another example, upstream friction reduction tool **10b** may be configured to be activated before downstream friction reduction tool **10a**. In this embodiment, a smaller increase in media flow rate and/or media density will activate friction reduction tool **10b**, while a larger increase in media flow rate and/or media density will be required to activate friction reduction tool **10a**. This configuration may be achieved by sizing the nozzle provided within friction reduction tool **10b**'s activation sleeve **48** to be smaller than the nozzle provided within friction reduction tool **10a**'s activation sleeve **48**. Accordingly, two or more friction reduction tools **10** may be configured to be activated in any order within a drill string or coiled tubing string regardless of each friction reduction tool's position.

[0038] In some embodiments, downstream friction reduction tool **10a** may be introduced into the wellbore in the dynamic mode while one or more upstream friction reduction tools **10b** are introduced into the wellbore in the stationary mode, such that these upstream friction reduction tools **10b** may be activated with a single or multiple media operating condition adjustments while disposed in the wellbore. Alternatively, a conventional friction reduction tool that operates only in a dynamic mode to generate significant pressure pulses with media flow therethrough may be placed in the drill string **66** between downhole selectively activated friction reduction tool **10a** and the bottom hole assembly **70**.

[0039] As used herein, "above" and any other indication of a greater height or latitude shall also mean upstream, and "below" and any other indication of a lesser height or latitude shall also mean downstream. As used herein, "downhole string" shall include a series of drill string or pipe segments and a coiled tubing line, along with any components secured thereto, including without limitation shock assemblies or shock subs.

[0040] While preferred embodiments have been described, it is to be understood that the embodiments are illustrative only and that the scope of the invention is to be defined solely by the appended claims when accorded a full range of equivalents, many variations and modifications naturally occurring to those skilled in the art from a review hereof.

CLAIMS:

1. A downhole friction reduction tool, comprising:

a power assembly;

a valve assembly operatively connected downstream of the power assembly, the valve assembly including a rotating valve segment and a stationary valve segment; and

an activation assembly operatively connected downstream of the power assembly, wherein in a first position the activation assembly provides a bypass flow path around the valve assembly for at least a portion of a media flow through the power assembly, wherein the activation assembly is configured to transition from the first position to a second position in response to a variation in an operating condition of the media flow, wherein in the second position of the activation assembly the bypass flow path is substantially closed;

wherein the power assembly is configured to rotate the rotating valve segment in relation to the stationary valve segment upon the media flow through the power assembly, wherein the valve assembly is configured to generate significant pressure pulses in a media flow column with the rotation of the rotating valve segment only when the activation assembly is in the second position.

2. The downhole friction reduction tool of claim 1, wherein the variation in the operating condition of the media flow is an increase in a flow rate of the media flow.

3. The downhole friction reduction tool of claim 1, wherein the variation in the operating condition of the media flow is an increase in a density of a media in the media flow.

4. The downhole friction reduction tool of claim 1, wherein the power assembly includes a Moineau motor having a single lobe rotor and a dual lobe stator.

5. The downhole friction reduction tool of claim 1, wherein the power assembly is configured to rotate the rotating valve segment when the activation assembly is in the first position and in the second position.

6. The downhole friction reduction tool of claim 1, wherein less than all of the media flow through the power assembly flows through the bypass flow path and a remainder of the media flow flows through the valve assembly when the activation assembly is in the first position; wherein substantially all of the media flow through the power assembly flows through the valve assembly when the activation assembly is in the second position.

7. The downhole friction reduction tool of claim 1, wherein all of the media flow through the power assembly flows through the bypass flow path when the activation assembly is in the first position; wherein substantially all of the media flow through the power assembly flows through the valve assembly when the activation assembly is in the second position.

8. The downhole friction reduction tool of claim 1, wherein the bypass flow path includes one or more bypass ports that are open in the first position of the activation assembly and closed in the second position of the activation assembly.

9. The downhole friction reduction tool of claim 8, wherein the activation assembly includes a sleeve, wherein the sleeve closes the one or more bypass ports in the second position of the activation assembly.

10. The downhole friction reduction tool of claim 9, wherein the sleeve includes one or more bypass openings that are aligned with the one or more bypass ports in the first position of the activation assembly and unaligned with the one or more bypass ports in the second position of the activation assembly.

11. A downhole friction reduction tool, comprising:

a power assembly including a positive displacement motor having a rotor and a stator, wherein the rotor contains no axial bore; wherein the rotor rotates within the stator upon a media flow through the power assembly;

a valve assembly operatively connected to the rotor; and

an activation assembly operatively connected downstream of the rotor, wherein in a first position the activation assembly provides a bypass flow path around the valve assembly for at least a portion of the media flow, wherein the activation assembly is configured to transition from the first position to a second position in response to a variation in an operating condition of the media flow, wherein in the second position of the activation assembly the bypass flow path is substantially closed;

wherein the valve assembly is configured to generate significant pressure pulses in a media flow column with the rotation of the rotor only when the activation assembly is in the second position.

12. The downhole friction reduction tool of claim 11, wherein the rotor is a single lobe rotor.

13. The downhole friction reduction tool of claim 11, wherein a rotating valve segment of the valve assembly rotates with rotation of the rotor when the activation assembly is in the first position and in the second position.

14. The downhole friction reduction tool of claim 11, wherein the variation in the operating condition of the media flow is an increase in a flow rate of the media flow.

15. The downhole friction reduction tool of claim 11, wherein the variation in the operating condition of the media flow is an increase in a density of a media in the media flow.

16. The downhole friction reduction tool of claim 11, wherein the bypass flow path includes one or more bypass ports that are open in the first position of the activation assembly and closed in the second position of the activation assembly.

17. The downhole friction reduction tool of claim 16, wherein the activation assembly includes a sleeve, wherein the sleeve closes the one or more bypass ports in the second position of the activation assembly.

18. A method of selectively generating a pressure pulse in a downhole string, comprising the steps of:

a) providing one or more selectively activated friction reduction tools each comprising: a power assembly; a valve assembly operatively connected downstream of the power assembly, the valve assembly including a rotating valve segment and a stationary valve segment; and an activation assembly operatively connected downstream of the power assembly, wherein in a first position the activation assembly provides a bypass flow path around the valve assembly for at least a portion of the media flow, wherein the activation assembly is configured to transition from the first position to a second position in response to a variation in an operating condition of the media flow, wherein in the second position of the activation assembly the bypass flow path is substantially closed; wherein the power assembly is configured to rotate the rotating valve segment in relation to the stationary valve segment upon a media flow through the power assembly; wherein the valve assembly is configured to generate significant pressure pulses in a media flow column with the rotation of the rotating valve segment only when the activation assembly is in the second position;

b) securing the one or more friction reduction tools with the activation assembly in the first position between segments of the downhole string; wherein the downhole string includes a drill string or a coiled tubing line;

c) lowering the downhole string with the one or more friction reduction tools into a wellbore;

d) pumping a media through the downhole string and the one or more friction reduction tools; wherein the media causes the power assembly of each friction reduction tool to rotate the rotating valve segment of the valve assembly; wherein at least a portion of the media flows through the bypass flow path around the valve assembly when the activation assembly is in the first position; wherein no significant pressure pulse is generated by the valve assembly with the activation assembly in the first position;

e) selectively activating an activated friction reduction tool selected from the one or more friction reduction tools while positioned within the wellbore by varying the operating condition of the media to transition the activation assembly of the activated friction reduction tool from the first position to the second position in which the bypass flow path is substantially closed; and

f) continuing to pump media through the downhole string and the one or more friction reduction tools with the activation assembly of the activated friction reduction tool in the second position; wherein the media continues to cause the power assembly to rotate the rotating valve segment of the valve assembly and substantially all of the media flows through the valve assembly with the activation assembly in the second position in the activated friction reduction tool; wherein the rotation of the rotating valve segment of the valve assembly in the activated friction reduction tool generates significant pressure pulses that are transmitted to the downhole string.

19. The method of claim 18, wherein in step (e) varying the operating condition of the media comprises increasing a flow rate of the media.

20. The method of claim 18, wherein in step (e) varying the operating condition of the media comprises increasing a density of the media.

21. The method of claim 18, wherein in step (f) the generated significant pressure pulses stretch the drill string, a shock sub connected to the drill string, or the coiled tubing line to generate an axial vibration.

22. The method of claim 18, wherein in step (e) the activation assembly of the activated friction reduction tool is transitioned from the first position to the second position by sliding a

sleeve of the activation assembly into a position in which the sleeve closes one or more bypass ports of the activation assembly to close or limit the bypass flow path.

23. The method of claim 18, wherein in step (b) the one or more friction reduction tools include a downhole tool and an upstream tool that are both secured within the downhole string with the downstream tool downstream of the upstream tool; wherein in step (e) the upstream tool is selectively activated by the variation of the operating condition of the media without selectively activating the downstream tool; wherein in step (f) the upstream tool generates significant pressure pulses while the downstream tool does not generate significant pressure pulses.

24. The method of claim 23, further comprising the steps of:

g) selectively activating the downstream tool while positioned within the wellbore by a second variation in the operating condition of the media after the upstream tool has been activated; and

h) continuing to pump media through the downhole string, the upstream tool, and the downstream tool with the activation assembly of each of the downstream and upstream tools in the second position; wherein the media continues to cause the power assembly to rotate the rotating valve segment of each of the downstream and upstream tools to generate significant pressure pulses with both the downstream and upstream tools.

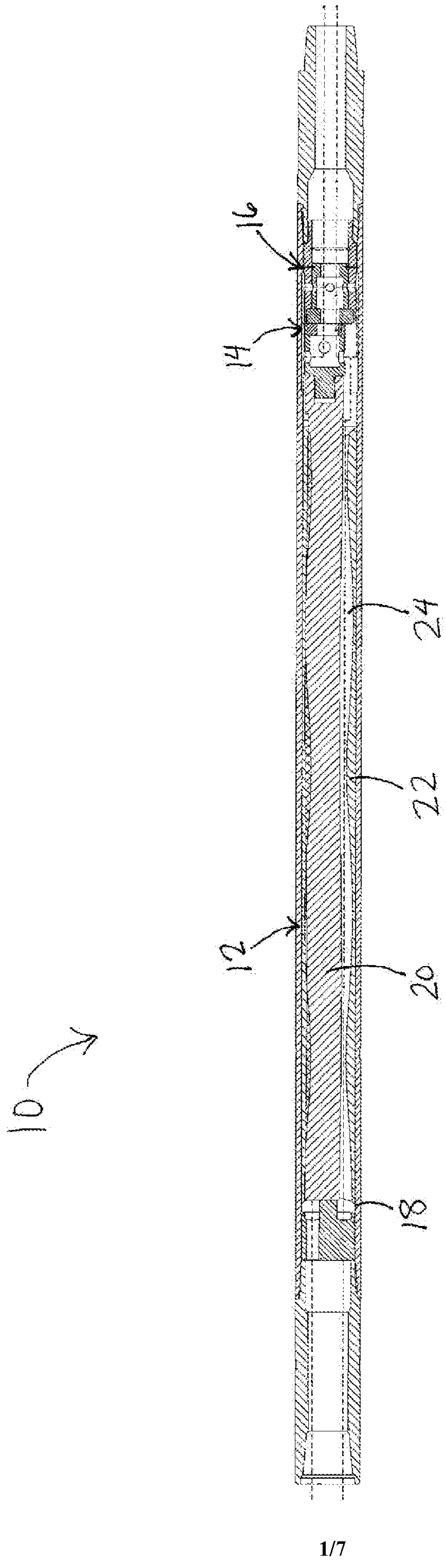

Fig. 1

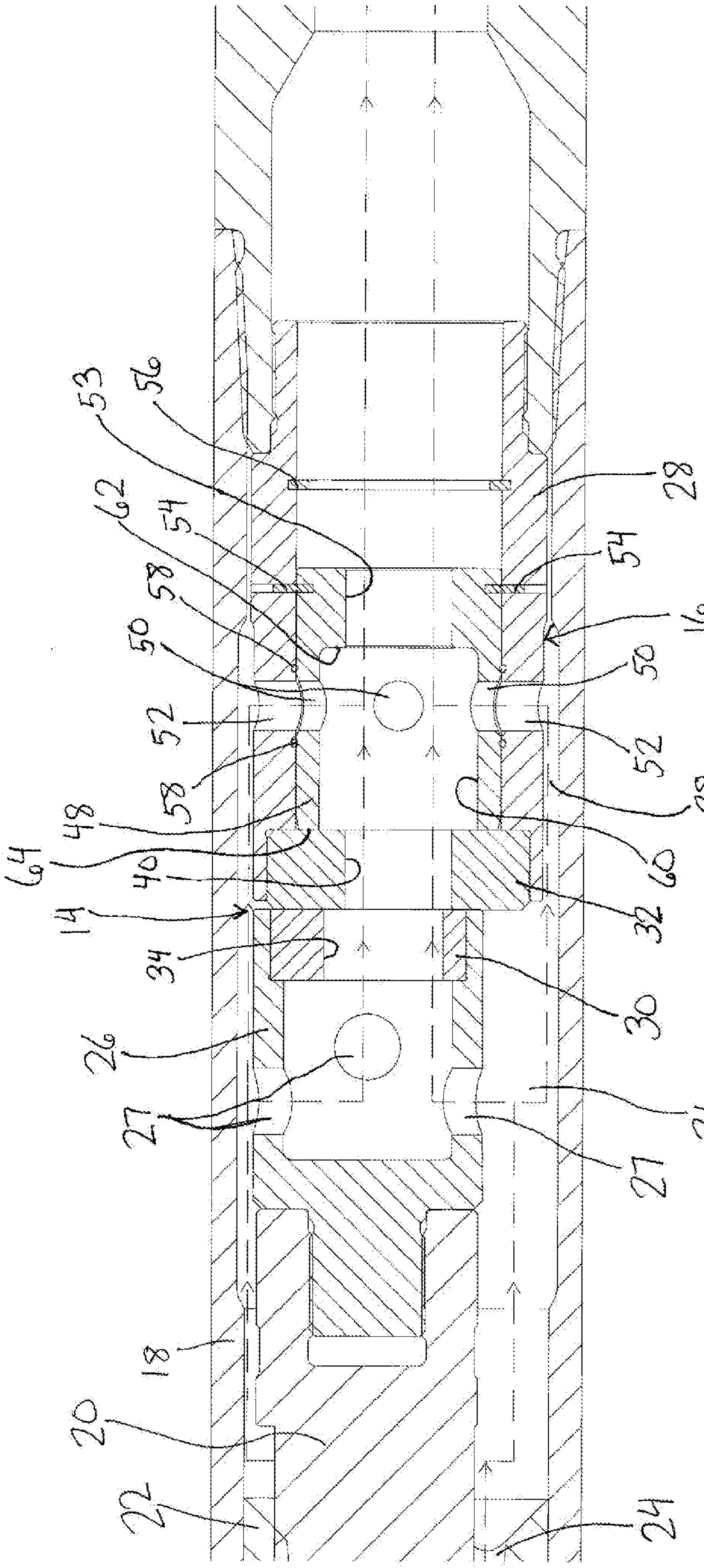
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Fig. 2

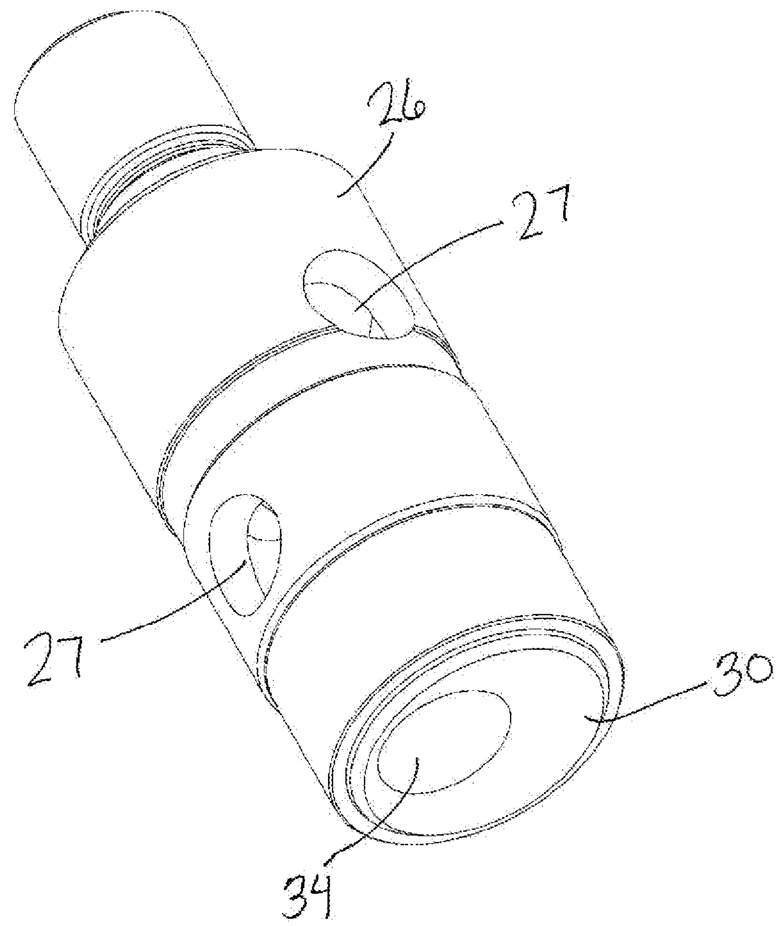

Fig. 3

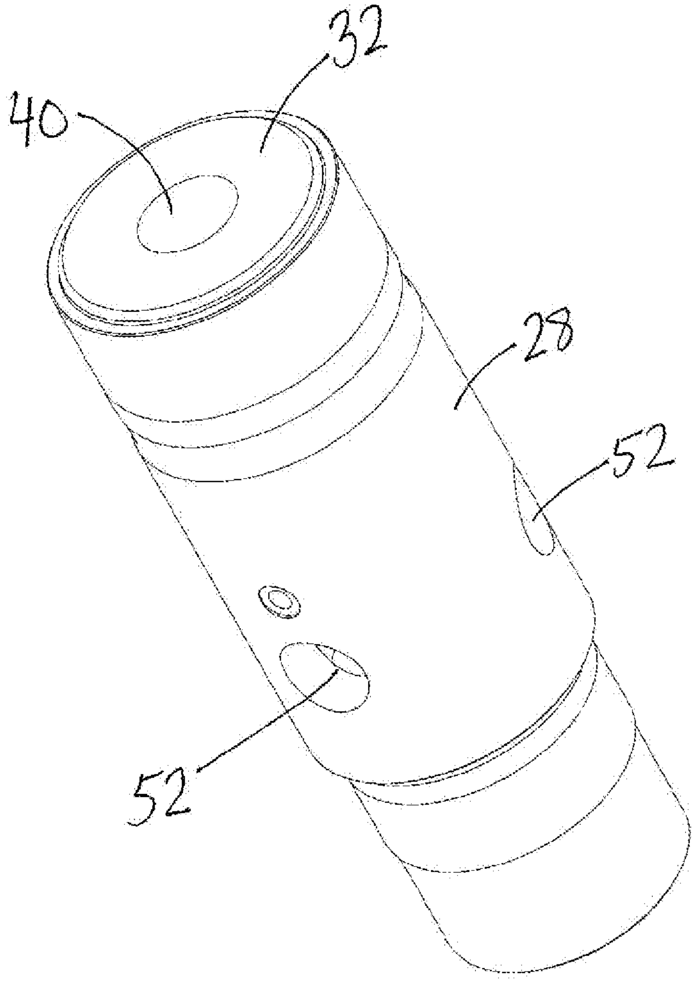

Fig. 4

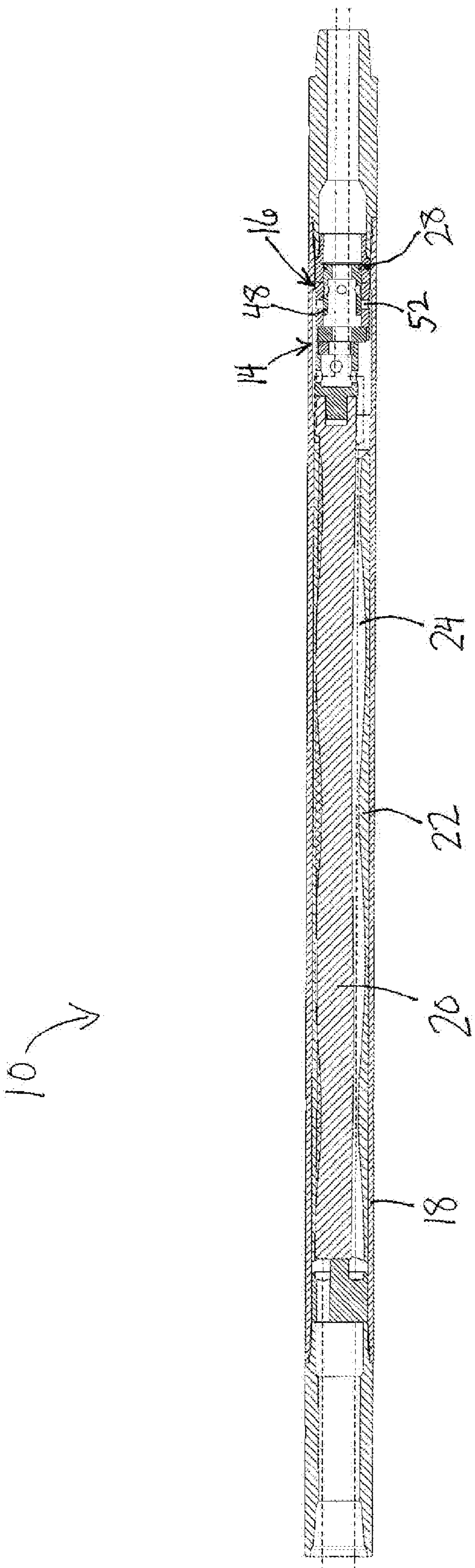

Fig. 5

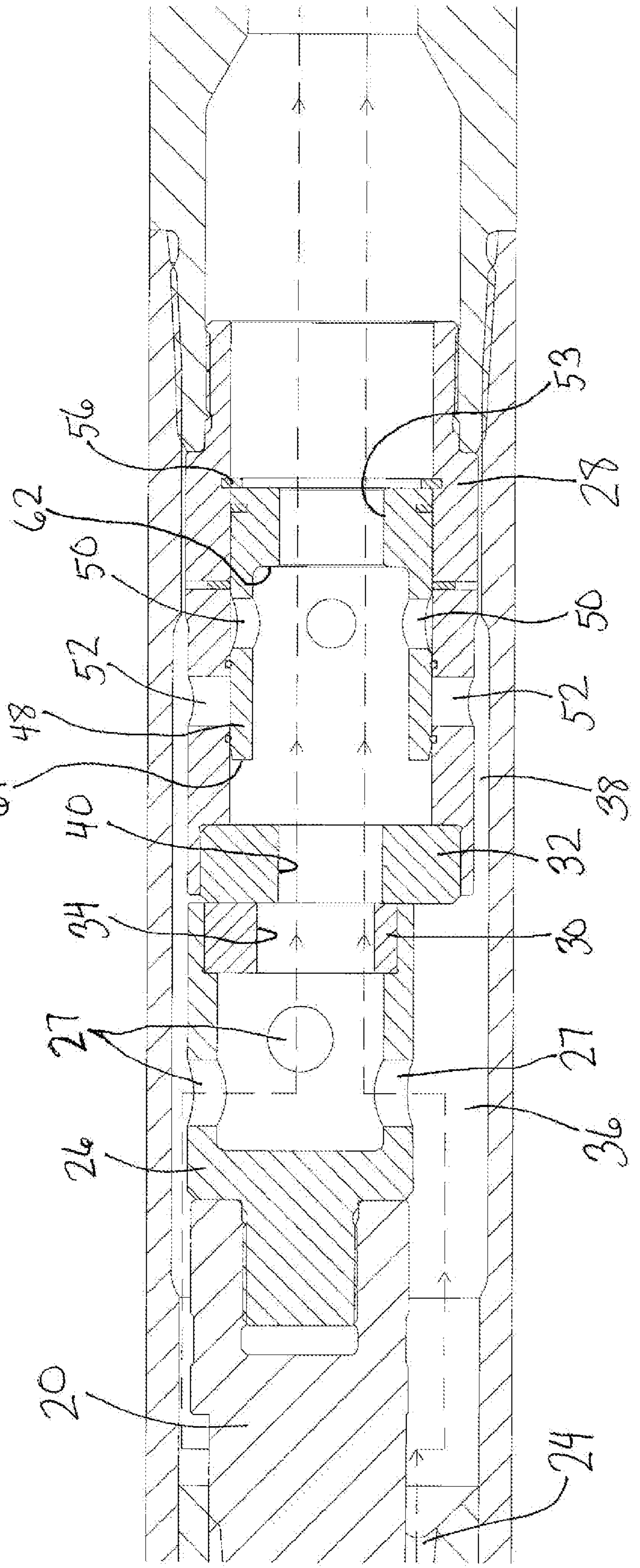

Fig. 6

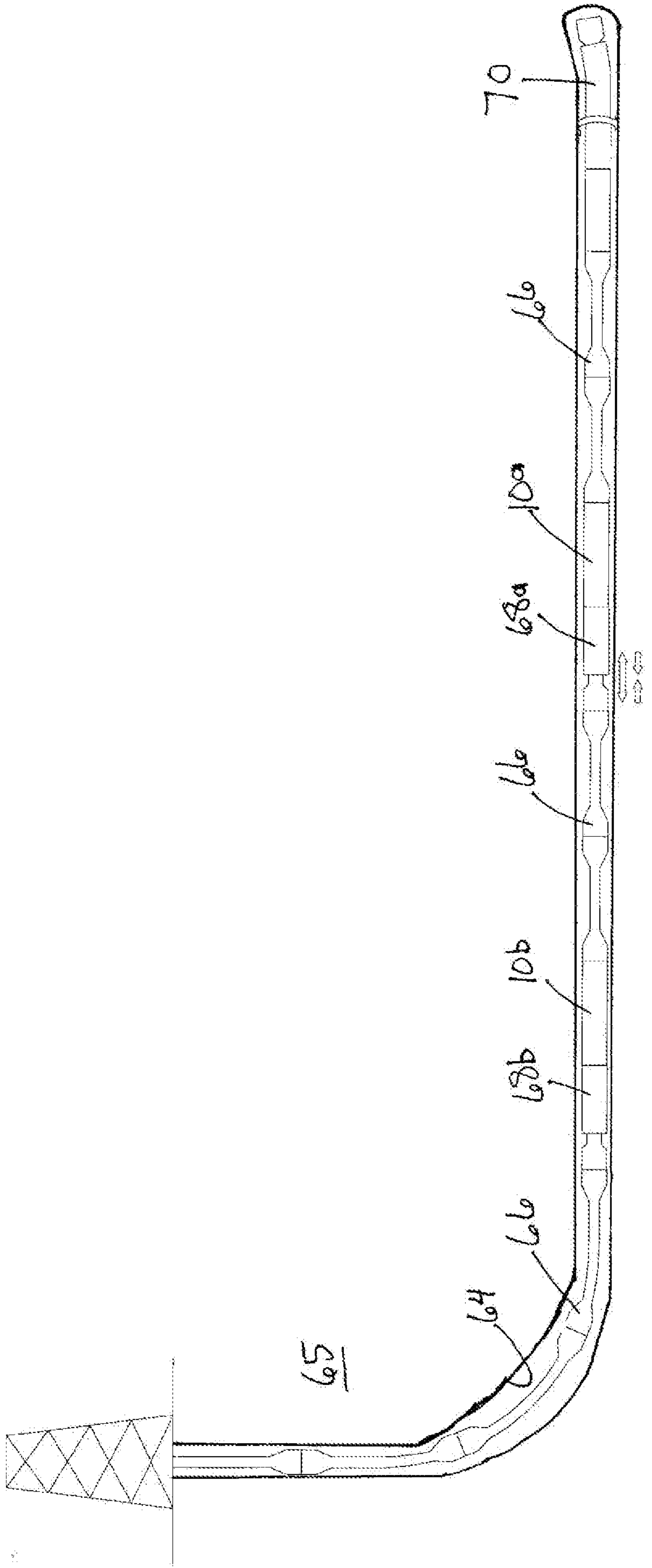

Fig. 7

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2024/023721

A. CLASSIFICATION OF SUBJECT MATTER

IPC: ***E21B 28/00*** (2024.01); ***E21B 34/08*** (2024.01); ***E21B 7/24*** (2024.01); ***E21B 21/10*** (2024.01)

CPC: ***E21B 28/00; E21B 21/103; E21B 34/08; E21B 7/24;*** *E21B 31/005*

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

See Search History Document

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

See Search History Document

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

See Search History Document

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2011/0073374 A1 (BUNNEY et al.) 31 March 2011 (31.03.2011) entire document	1, 4, 5, 8, 11-13, 16
Y	US 2017/0016289 A1 (GILLIS) 19 January 2017 (19.01.2017) entire document	1, 4, 5, 8, 11-13, 16
A	US 2021/0040808 A1 (ARRIVAL OIL TOOLS INC.) 11 February 2021 (11.02.2021) entire document	1-24
A	US 2009/0223676 A1 (EDDISON et al.) 10 September 2009 (10.09.2009) entire document	1-24
A	US 2008/0271923 A1 (KUSKO et al.) 06 November 2008 (06.11.2008) entire document	1-24

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:
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- "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- "O" document referring to an oral disclosure, use, exhibition or other means
- "P" document published prior to the international filing date but later than the priority date claimed
- "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
- "&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
26 June 2024 (26.06.2024)	**12 July 2024 (12.07.2024)**

Name and mailing address of the ISA/US	Authorized officer
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