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(54) **DOWNHOLE FLUID-PRESSURE SAFETY BYPASS APPARATUS**

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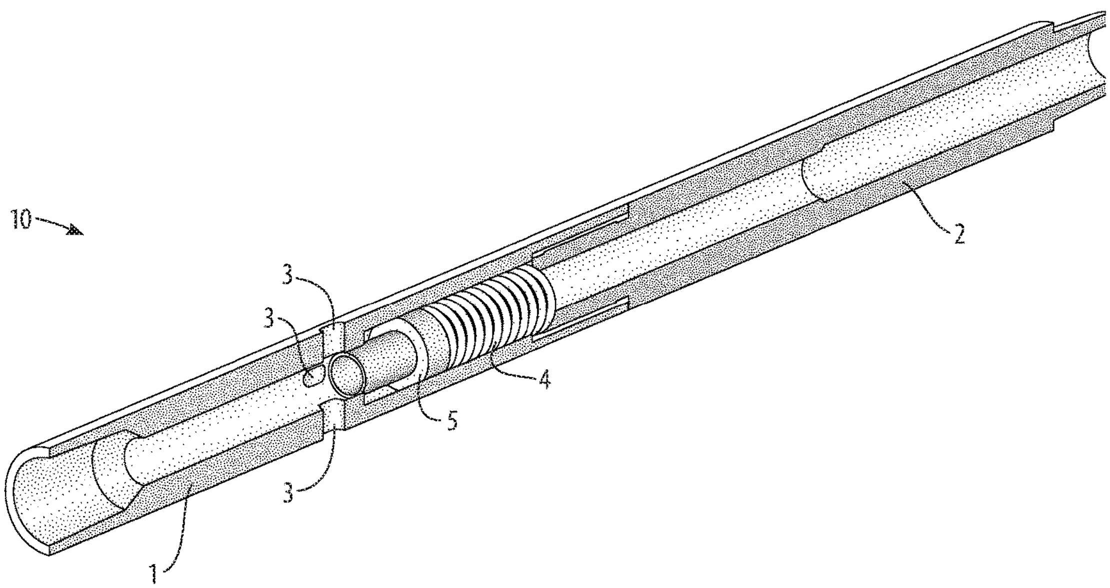
(57) **ABSTRACT**

A downhole fluid-pressure safety bypass for coiled-tubing operations, which diverts excessively pressurized drilling fluid directly into the annulus, protecting the fluid motor and similar downhole equipment from damage or reduced function, while allowing greater fluid pressures to be used up-hole for purposes such as increasing the flushing of cuttings up the annulus.



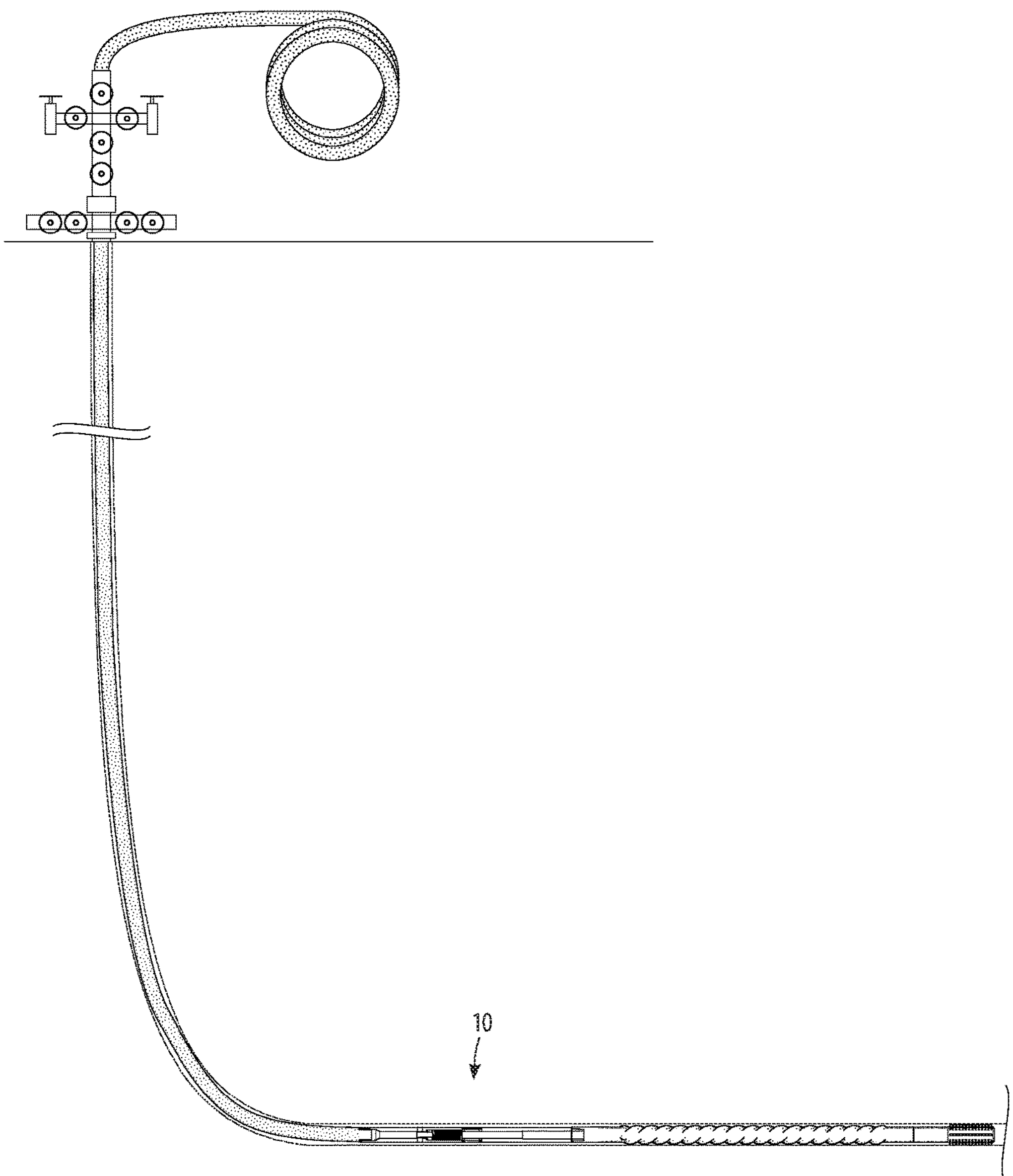



FIG. 1

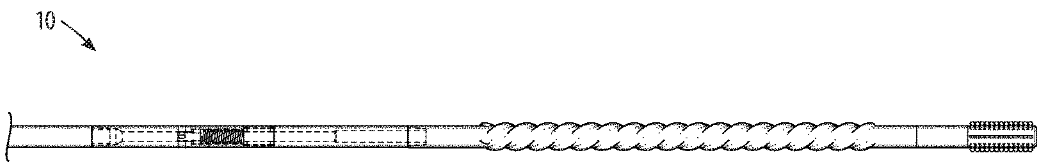



FIG. 2

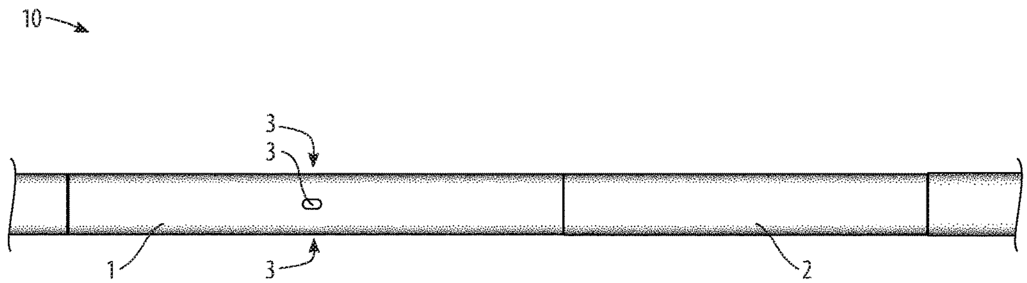



FIG. 3

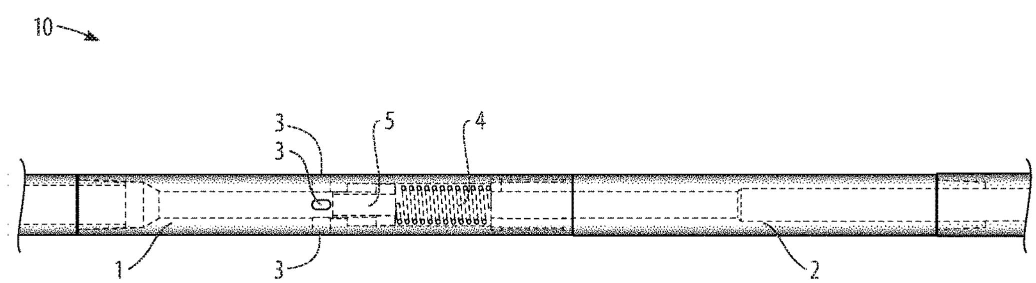



FIG. 4

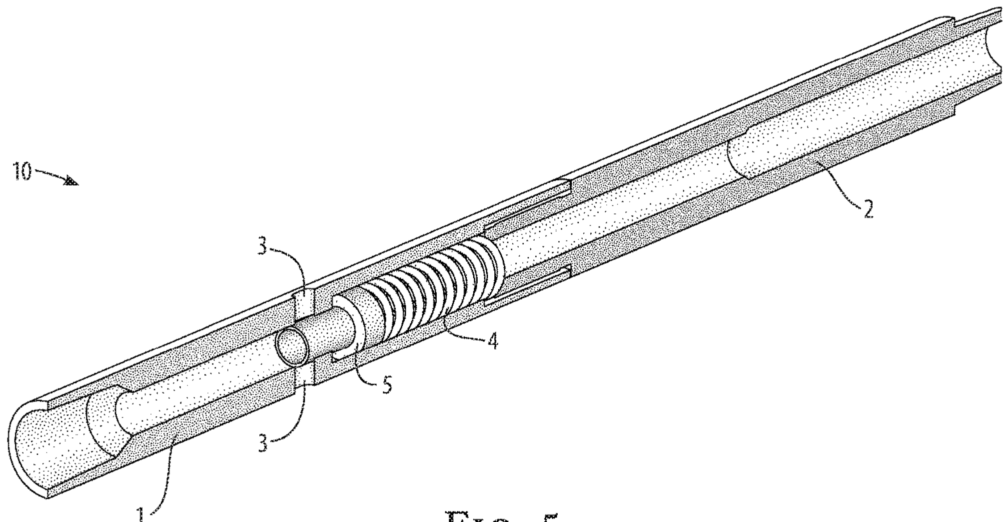



FIG. 5

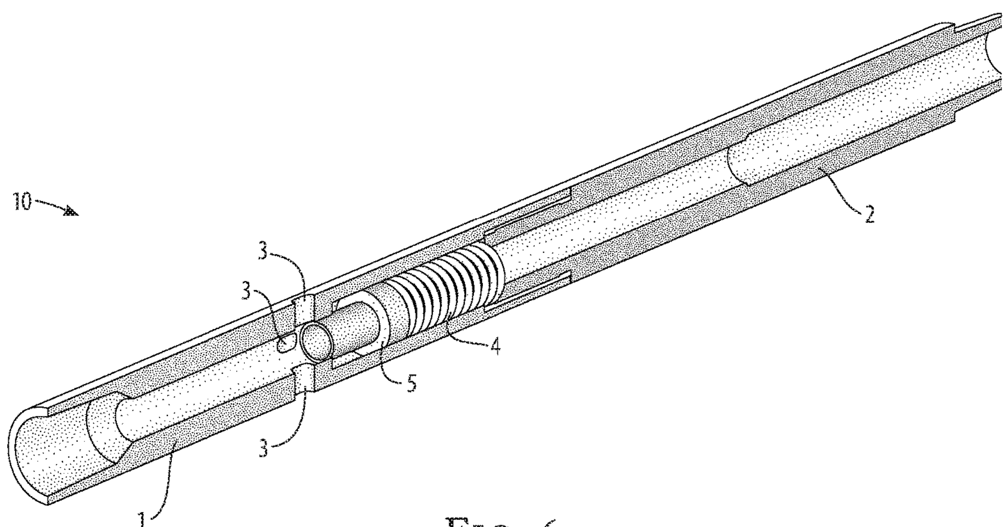



FIG. 6

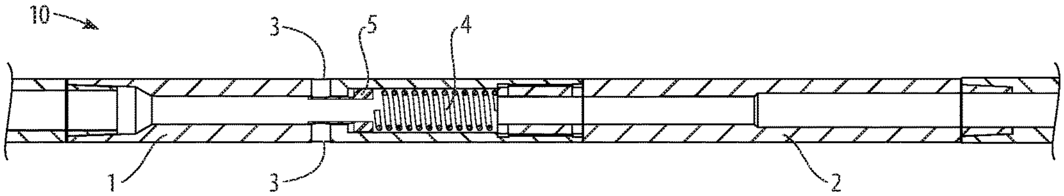



FIG. 7

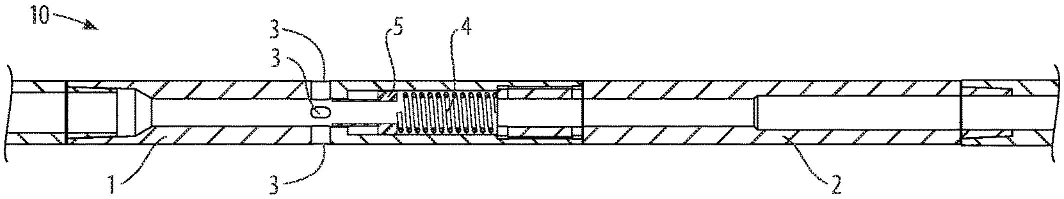



FIG. 8

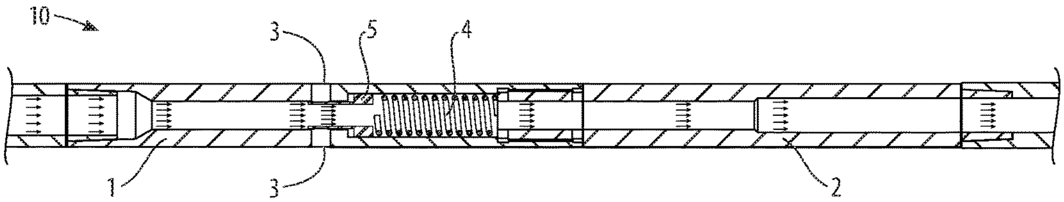



FIG. 9

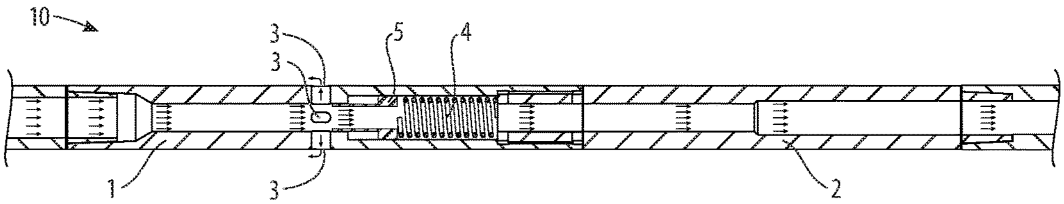



FIG. 10

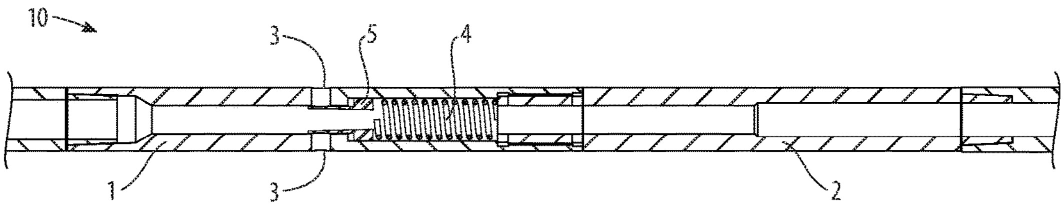



FIG. 11

# DOWNHOLE FLUID-PRESSURE SAFETY BYPASS APPARATUS

## CROSS-REFERENCE TO RELATED APPLICATIONS

**[0001]** This application is a continuation-in-part of my co-pending application, "Downhole Pulsing Shock-Reach Extender System," filed Dec. 28, 2016, Ser. No. 15/392,846, the full disclosure of which is incorporated by reference and priority of which is hereby claimed.

## BACKGROUND OF THE INVENTION

**[0002]** This invention provides a downhole fluid-pressure safety bypass which diverts excessively pressurized drilling fluid directly into the annulus, protecting the fluid motor from damage and increasing the flow of cuttings up the annulus.

**[0003]** In coiled-tubing operations such as drilling and workover, a workstring of equipment is mounted on the downhole end of coiled tubing and sent down the hole. Drilling fluid or drilling mud is pumped downhole through the coiled tubing. A fluid motor or mud motor is a standard component of a workstring. The fluid motor uses drilling fluid under pressure to produce rotational force to drive drilling or milling bits. An annulus space exists outside the coiled tubing and the workstring. Drilling fluid is expelled by the downhole components of the workstring for cooling and lubrication, and for flushing cuttings back up and out of the hole.

**[0004]** A fluid motor or mud motor has a desired maximum pressure of drilling fluid that it can tolerate. Above that desired maximum pressure, the fluid motor is susceptible to damage such as delamination and erosion of a rubber sleeve that is essential to the proper performance of the motor. Other downhole equipment might have similar desired maximum pressures or optimal pressures.

**[0005]** There might be other equipment mounted up-hole on the workstring from the fluid motor, and that up-hole equipment might require a drilling-fluid pressure in excess of the maximum pressure that the fluid motor or similar downhole equipment can tolerate without damage or reduced performance, or that up-hole equipment might produce such excess pressure. Alternatively, there might be no other such up-hole equipment, but pressures above the maximum tolerable pressure might be needed for reasons like improved flushing up the annulus, or might occur inadvertently.

**[0006]** There is a need for providing increased drilling-fluid pressure up-hole from the fluid motor while preventing excessive pressure from reaching the fluid motor.

**[0007]** U.S. Publ. No. 2016/0312559 was published on Oct. 27, 2016 by inventors Ilia Gotlib et al. and assignee Sclumberger Technology Corp., and covers a "Pressure Pulse Reach Extension Technique." The pressure pulse tool and technique allows for a reciprocating piston at a frequency independent of a flow rate of the fluid that powers the reciprocating. The architecture of the tool and techniques employed may take advantage of a Coanda or other implement to alternatingly divert fluid flow between pathways in communication with the piston in order to attain the reciprocation. Frequency of reciprocation may be between about 1 Hz and about 200 Hz, or other suitably tunable ranges. Once more, the frequency may be enhanced through periodic exposure to annular pressure. Extended reach through use of such a pressure pulse tool and technique may exceed about 2,000 feet.

**[0008]** U.S. Publ. No. 2016/0130938 was published on May 12, 2016 by inventor Jack J. Koll and assignee Tempress Technologies, Inc., and discloses "Seismic While Drilling System and Methods." A bottom hole assembly is configured with a drill bit section connected to a pulse generation section. The pulse generation section includes a relatively long external housing, a particular housing length being selected for the particular drilling location. The long external housing is positioned closely adjacent to the borehole sidewalls to thereby create a high-speed flow course between the external walls of the housing and the borehole sidewalls. The long external housing includes a valve cartridge assembly and optionally a shock sub decoupler. While in operation, the valve cartridge assembly continuously cycles and uses downhole pressure to thereby generate seismic signal pulses that propagate to geophones or other similar sensors on the surface. The amount of bypass allowed through the valve assembly is selectable in combination with the long external housing length and width to achieve the desired pulse characteristics. The bottom hole assembly optionally includes an acoustic baffle to attenuate wave propagation going up the drill string.

**[0009]** U.S. Publ. No. 2014/0048283, published by Brian Mohon et al. on Feb. 20, 2014, covers a "Pressure Pulse Well Tool." The disclosure of the Mohen publication is directed to a pressure pulse well tool, which may include an upper valve assembly configured to move between a start position and a stop position in a housing. The pressure pulse well tool may also include an activation valve subassembly disposed within the upper valve assembly. The activation valve subassembly may be configured to restrict a fluid flow through the upper valve assembly and increase a fluid pressure across the upper valve assembly. The pressure pulse well tool may further include a lower valve assembly disposed inside the housing and configured to receive the fluid flow from the upper valve assembly. The lower valve assembly may be configured to separate from the upper valve assembly after the upper valve assembly reaches the stop position, causing the fluid flow to pass through the lower valve assembly and to decrease the fluid pressure across the upper valve assembly.

**[0010]** U.S. Pat. No. 8,082,941 issued Dec. 27, 2011 to Alessandro O. Caccialupi et al. for a "Reverse Action Flow Activated Shut-Off Valve." The Caccialupi flow-activated valve includes an outer body and a piston disposed in an inner cavity of the outer body. The flow-activated valve also includes one or more fluid passage exits in the outer body and one or more piston fluid passages in the piston. The one or more fluid passage exits and the one or more piston fluid passages allow fluid flow out of the valve. The flow-activated valve also includes a flow restriction member disposed in a piston inner cavity. In addition, the flow-activated valve includes a shear member disposed in the outer body, and a bias member disposed in an inner cavity of the outer body. The flow-activated valve further includes a position control member disposed in the piston and a sealing member.

**[0011]** U.S. Pat. No. 7,343,982 issued to Phil Mock et al. on Mar. 18, 2008 for a "Tractor with Improved Valve System." The system covers a hydraulically powered tractor adapted for advancement through a borehole, and includes an elongated body, aft and forward gripper assemblies, and a valve control assembly housed within the elongated body. The aft and forward gripper assemblies are adapted for selective engagement with the inner surface of the borehole. The valve control assembly includes a gripper control valve for directing pressurized fluid to the aft and forward gripper assemblies. The valve control assembly also includes a propulsion control valve for directing fluid to an aft or forward power chamber for advancing the body relative to the actuated gripper assembly. Aft and forward mechanically actuated valves may be provided for controlling the position of the gripper control valve by detective and signaling when the body has completed an advancement stroke relative to an actuated gripper assembly. Aft and forward sequence valves may be provided for controlling the propulsion control valve by detecting when the gripper assemblies become fully actuated. A pressure relief valve is preferably provided along an input supply line for liming the pressure of the fluid entering the valve control assembly.

**[0012]** U.S. Pat. No. 2,576,923, issued on Dec. 4, 1951 to Clarence J. Coberly for a "Fluid Operated Pump with Shock Absorber," relates in general to equipment for pumping fluid from wells and, more particularly, to an apparatus which includes a reciprocating pump of the fluid-operated type. A primary object of the invention is to provide an apparatus having cushioning means associated therewith for absorbing any fluid pressure variations which may impose hydraulic shock loads on the system. The fluid operated pumping unit includes a combination of (1) a source of a first fluid at a substantially constant pressure level; (2) a receiver for a second fluid to be pumped; (3) a pump adapted to be operating by the first fluid to pump the second fluid; (4) a shock absorber connected to the pump and having movable fluid separating means within it; (5) means for a first passage communicating between the source and the shock absorber for admitting the first fluid into the shock absorber on one side of the fluid separating means; (6) and a second passage means communicating between the receiver and the shock absorber for admitting the second fluid into the shock absorber on the opposite side of the fluid separating means.

**[0013]** U.S. Pat. No. 8,967,268, issued to Larry J. Urban et al. on Mar. 3, 2015, covers "Setting Subterranean Tools with Flow Generated Shock Wave." In the Urban patent, a circulation sub is provided that has a ball seat and a circulation port that is closed when a ball is landed on the seat. An axial passage directs the pressure surge created with the landing of the ball on the seat to the port with the actuation piston for the tool. The surge in pressure operations the actuation piston to set the tool, which is preferably a packer. Raising the circulation rate through a constriction in a circulation sub breaks a shear device and allows the restriction to shift to cover a circulation port. The pressure surge that ensues continues through the restriction to the actuating piston for the tool to set the tool. The Urban patent was assigned to Baker Hughes Inc. on Nov. 30, 2011.

**[0014]** U.S. Pat. No. 8,939,217, issued Jan. 27, 2015 to inventor Jack J. Koll and assignee Tempress Technologies, Inc., covers a "Hydraulic Pulse Valve with Improved Pulse Control," pictured at right. Hydraulic pulses are produced each time that a pulse valve interrupts the flow of a pressurized fluid through a conduit. The pulse valve includes an elongated housing having an inlet configured to couple the conduit to receive the pressurized fluid, and an outlet configured to couple to one or more tools. In the housing, a valve assembly includes a poppet reciprocating between open and closed positions, and a poppet seat, in which the poppet closes to at least partially block the flow of pressurized fluid through the valve. A pilot within the poppet moves between disparate positions to modify fluid paths within the valve. When the valve is open, a relatively lower pressure is produced by a Venturi effect as the fluid flows through a throat in the poppet seat, to provide a differential pressure used to move the pilot and poppet. An optional bypass reduces the pulse amplitude.

## SUMMARY OF THE INVENTION

**[0015]** This invention provides a downhole fluid-pressure safety bypass for coiled-tubing operations, which diverts excessively pressurized drilling fluid directly into the annulus, protecting the fluid motor and similar downhole equipment from damage or reduced function, while allowing greater fluid pressures to be used up-hole for purposes such as increasing the flushing of cuttings up the annulus.

**[0016]** At normal fluid pressures, all fluid flows through a flow-through sliding inner tube which is held in a position blocking fluid bypass ports by a calibrated coiled spring. At excessive fluid pressures, the calibrated coiled spring is overcome and the flow-through sliding inner tube slides into a position not blocking the fluid bypass ports, and the excessive portion of the fluid flow is diverted directly into the annulus.

## BRIEF DESCRIPTION OF DRAWINGS

**[0017]** Reference will now be made to the drawings, wherein like parts are designated by like numerals, and wherein:

**[0018]** FIG. **1** is a schematic view of the downhole fluid-pressure safety bypass of the invention, in use;

**[0019]** FIG. **2** is a side view of the downhole fluid-pressure safety bypass of the invention, in use;

**[0020]** FIG. **3** is a side view of the downhole fluid-pressure safety bypass of the invention;

**[0021]** FIG. **4** is a side view showing hidden internal components of the downhole fluid-pressure safety bypass of the invention;

**[0022]** FIG. **5** is an oblique partial-cutaway view of the downhole fluid-pressure safety bypass of the invention with closed ports;

**[0023]** FIG. **6** is an oblique partial-cutaway view of the downhole fluid-pressure safety bypass of the invention with open ports;

**[0024]** FIG. **7** is an axial sectional view of the downhole fluid-pressure safety bypass of the invention with closed ports;

**[0025]** FIG. **8** is an axial sectional view of the downhole fluid-pressure safety bypass of the invention with open ports;

**[0026]** FIG. **9** is an axial sectional schematic view of the downhole fluid-pressure safety bypass of the invention with closed ports;

**[0027]** FIG. **10** is an axial sectional schematic view of the downhole fluid-pressure safety bypass of the invention with open ports; and

**[0028]** FIG. **11** is an axial sectional view showing an internally tapering flow-through sliding inner tube.

DETAILED DESCRIPTION OF THE DRAWINGS

**[0029]** Referring to FIG. **1** & FIG. **2**, the downhole fluid-pressure safety bypass **10** of the invention is intended for use in coiled-tubing operations such as drilling and workover. The downhole fluid-pressure safety bypass **10** is mounted on a workstring up-hole from equipment such as a fluid motor or mud motor driving a drilling or milling bit.

**[0030]** The coiled tubing and the workstring have a central axial conduit for drilling fluid which is of a standard cross-sectional area. For the usual round tubing, the cross-sectional area is the internal diameter of the tubing. This standard cross-sectional area or internal diameter is large in relation to the total area or diameter of the tubing.

**[0031]** Referring to FIG. **3** & FIG. **4**, the externally visible components of the downhole fluid-pressure safety bypass **10** are an intake tube section **1**, an outflow tube section **2**, and one or more fluid bypass ports **3** located in the middle portion of the intake tube section **1**. The internal components of the downhole fluid-pressure safety bypass **10** are a calibrated coiled spring **4** and a flow-through sliding inner tube **5**.

**[0032]** Referring to FIG. **5**, FIG. **6**, FIG. **7**, & FIG. **8**, the intake tube section **1** and outflow tube section **2** have a central axial conduit for drilling fluid to flow through. The cross-sectional area, or the diameter for standard round tubing, of the central axial conduit changes dependent on position along the route of flow. At the up-hole portion of the intake tube section **1** the cross-sectional area of the central axial conduit tapers down from the standard cross-sectional area of the coiled tubing and workstring to a smaller cross-sectional area, called the first cross-sectional area. Fluid flowing into this portion will undergo an increase in pressure.

**[0033]** The up-hole portion of the outflow tube section **2** central axial conduit has the same or nearly the same first cross-sectional area as the up-hole portion of the intake tube section **1**. The downhole portion of the outflow tube section **2** has an increase in cross-sectional area, where fluid pressure will decrease before the fluid flows into the downhole continuation of the workstring, such as the fluid motor.

**[0034]** One or more fluid bypass ports **3** located in the middle portion of the intake tube section **1** provide a path of flow out of the central axial conduit into the annulus.

**[0035]** The downhole portion of the intake tube section **1** has an increase in cross-sectional area which accommodates a calibrated coiled spring **4** and a portion of a flow-through sliding inner tube **5**. A shoulder is defined at the transition from the first cross-sectional area to the increased cross-sectional area.

**[0036]** The flow-through sliding inner tube **5** has an up-hole portion with an external size matching the first cross-sectional area of the intake tube section **1**. This portion of the flow-through sliding inner tube **5** can slide back and forth through the up-hole portion of the intake tube section **1**. A downhole portion of the flow-through sliding inner tube **5** has an increase in external size matching the cross-sectional area at the downhole portion of the intake tube section **1**, and can slide within that portion. A shoulder is defined at the transition. The flow-through sliding inner tube **5** has a central axial conduit that is necessarily somewhat smaller than the first cross-sectional area. When the flow-through sliding inner tube **5** is positioned at an up-hole extreme, with the shoulders of the central axial conduit and the flow-through sliding inner tube **5** in contact each with the other, the flow-through sliding inner tube **5** blocks the fluid bypass ports **3**, preventing any flow of drilling fluid through those fluid bypass ports **3**. When the flow-through sliding inner tube **5** is positioned downhole, it does not block the fluid bypass ports **3** or only partially blocks them.

**[0037]** A calibrated coiled spring **4** is placed just downhole of the flow-through sliding inner tube **5**, and is held in place by the up-hole end of the outflow tube section **2** when the intake tube section **1** and outflow tube section **2** are joined. The calibrated coiled spring **4** allows the flow of drilling fluid. The calibrated coiled spring **4** presses the flow-through sliding inner tube **5** towards an up-hole extreme, where further movement is stopped by the shoulder-to-shoulder contact. The spring is calibrated to be overcome at a desired set pressure acting upon the flow-through sliding inner tube **5**.

**[0038]** Referring to FIG. **9** & FIG. **10**, in use, pressurized drilling fluid from the coiled tubing will enter the up-hole portion of the intake tube section **1** and undergo an increase in pressure due to the smaller first cross-sectional area of the central axial conduit. This increased or amplified pressure is proportional to the pressure supplied by the coiled tubing. This amplified pressure will work upon the flow-through sliding inner tube **5**. Where the amplified pressure is at or below a level corresponding to a desired maximum fluid pressure, the calibrated coiled spring **4** will hold the flow-through sliding inner tube **5** at its up-hole extreme, blocking the fluid bypass ports **3**, and channeling all of the drilling fluid through the outflow tube section **2** an on to the downhole continuation of the workstring. Where the amplified pressure exceeds the level corresponding to a desired maximum fluid pressure, the counter-force of the calibrated coiled spring **4** is overcome and the flow-through sliding inner tube **5** moves downhole, opening or partially opening the fluid bypass ports **3**, allowing a portion of the flow of drilling fluid to be diverted into the annulus.

**[0039]** After passing through the flow-through sliding inner tube **5** at amplified pressure, the drilling fluid enters the larger downhole portion of the outflow tube section **2** and undergoes a lowering of pressure.

**[0040]** Referring additionally to FIG. **11**, the amplified fluid pressure operating upon the flow-through sliding inner tube **5** encounters resistance from the up-hole face and from the interior surface of the flow-through sliding inner tube **5**. This resistance can be increased by making the cross-sectional area of the central axial conduit through the flow-through sliding inner tube **5** smaller, either uniformly smaller or tapering down. A uniformly smaller cross-sectional area would create a larger up-hole face on the flow-through sliding inner tube **5**, which might lead to turbulence and wear under some conditions. A tapering transition would not cause as much turbulence and wear.

**[0041]** Many changes and modifications can be made in the present invention without departing from the spirit thereof. I therefore pray that my rights to the present invention be limited only by the scope of the appended claims.

I claim:

**1**. A downhole fluid-pressure safety bypass apparatus for coiled-tubing operations having an annulus and having an up-hole and downhole orientation, on a workstring having a central axial conduit for drilling fluid of a standard cross-sectional area, and a desired maximum pressure of drilling fluid in the downhole side of the workstring, the downhole fluid-pressure safety bypass comprising:

(i) an intake tube section adapted to mount at an up-hole end to a coiled-tubing workstring, having at an up-hole end extending to the middle portion of said intake tube section a central axial conduit for drilling fluid of a first cross-sectional area smaller than standard, and having an enlargement of cross-sectional area at a downhole end, defining a shoulder;

(ii) an outflow tube section adapted to mount at an up-hole end to the downhole end of said intake tube section, and mount at a downhole end to the downhole continuation of the coiled-tubing workstring, having a central axial conduit for drilling fluid of size close to the first cross-sectional area of said intake tube section, and having an enlargement of cross-sectional area at a downhole end;

(iii) at least one fluid bypass port adapted to allow passage of drilling fluid from the middle portion of the central axial conduit of said intake tube section to the annulus;

(iv) a calibrated coiled spring adapted to fit into the enlarged-cross-sectional area of said intake tube section such that said calibrated coiled spring does not bind and does not block the flow of drilling fluid; and

(v) a flow-through sliding inner tube having an external size matching the first cross-sectional area of said intake tube section at an up-hole end, and having an increased external size larger than the first cross-sectional area of said intake tube section, defining a shoulder, at a downhole end, and having a central axial conduit for drilling fluid, adapted to slide inside said intake tube section and to block said fluid bypass ports when at an up-hole position and to not block said fluid bypass ports when at a downhole position;

where, in use, at fluid pressures up to the desired maximum, said flow-through sliding inner tube is pressed by said calibrated coiled spring into an up-hole position such that the shoulder of said flow-through sliding inner tube is stopped by contact with the shoulder of said intake tube section and said flow-through sliding inner tube blocks said fluid bypass ports, and all of the fluid flows through said flow-through sliding inner tube into said outflow tube section and into the downhole continuation of the coiled-tubing workstring;

where, in use, at fluid pressures above the desired maximum, said flow-through sliding inner tube is pressed to overcome said calibrated coiled spring and to slide into a downhole position such that said flow-through sliding inner tube does not block said fluid bypass ports, and a portion of the fluid flows through said fluid bypass ports into the annulus; and

where, in use, said downhole fluid-pressure safety bypass prevents excessively pressurized drilling fluid from flowing into the downhole continuation of the coiled-tubing workstring by diverting a portion of drilling fluid through said fluid bypass ports directly into the annulus, thereby increasing flow up the annulus.

**2**. The downhole downhole fluid-pressure safety bypass apparatus of claim **1**, further comprising being made of steel.

**3**. The downhole fluid-pressure safety bypass apparatus of claim **1**, where said intake tube section, said outflow tube section, and said flow-through sliding inner tube further have the form of round tubes.

**4**. The downhole fluid-pressure safety bypass apparatus of claim **1**, where said intake tube section and said outflow tube section have a largest external-surface diameter of between 2 and 2.5 inches, inclusive.

**5**. The downhole fluid-pressure safety bypass apparatus of claim **1**, where said flow-through sliding inner tube further comprises having a central axial conduit with a tapered decreasing cross-sectional area.

**6**. The downhole fluid-pressure safety bypass apparatus of claim **1**, further comprising more than one said fluid bypass port.

**7**. The downhole fluid-pressure safety bypass apparatus of claim **1**, further comprising more than two said fluid bypass ports.

**8**. The downhole fluid-pressure safety bypass apparatus of claim **1**, further comprising more than one said fluid bypass ports distributed radially about said intake tube section.

**9**. The downhole fluid-pressure safety bypass apparatus of claim **1**, further comprising more than one said fluid bypass ports distributed equidistantly about said intake tube section.

* * * * *