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(54) **SAFETY VALVE, METHOD, AND SYSTEM**

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(58) **Field of Classification Search**
CPC E21B 34/08; E21B 34/105; E21B 34/106; E21B 2000/05
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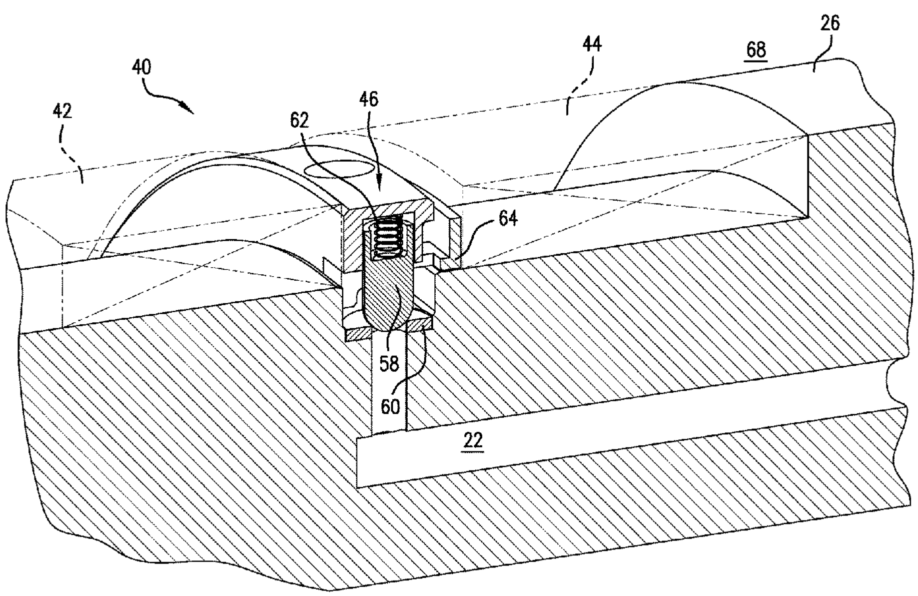
(57) **ABSTRACT**

An insert safety valve, including a housing, a flow tube in the housing, a flapper to positions of the flow tube, an atmospheric chamber in the housing, a selectively openable valve to prevent or allow pressure communication between the chamber and an environment, the valve including a valve member, a valve seat, and an unseat member to move the valve member off the valve seat. A borehole system, including a preexisting safety valve having a control line, an insert safety valve, in the preexisting safety valve, the insert safety valve operable with the control line. A method for controlling a wellbore, including running an insert safety valve while preventing fluid communication with an atmospheric chamber of the safety valve, moving the unseat member, and enabling fluid communication with the atmospheric chamber.

17 Claims, 6 Drawing Sheets



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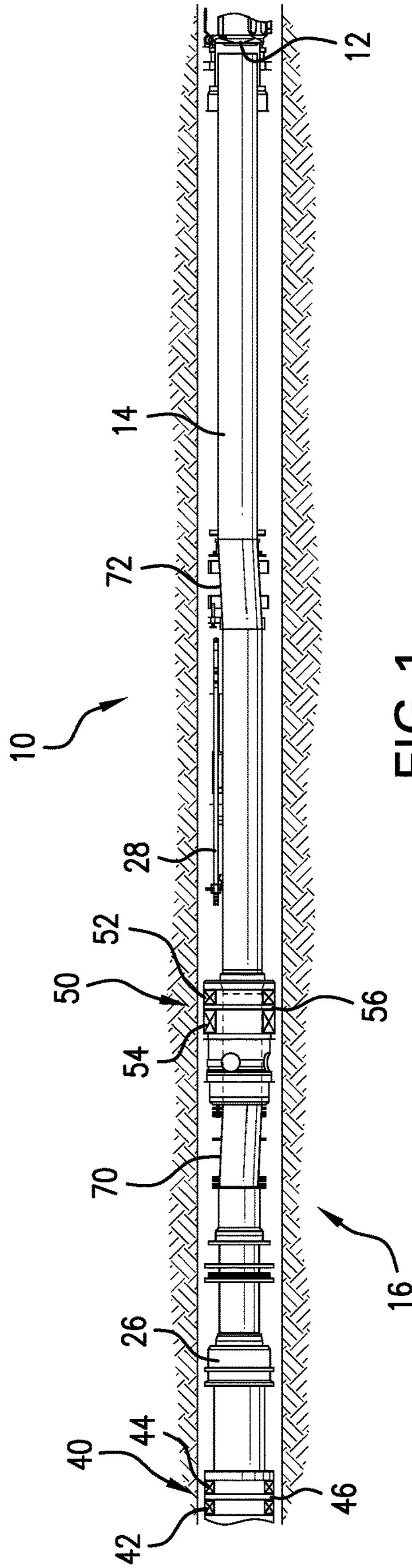

FIG. 1

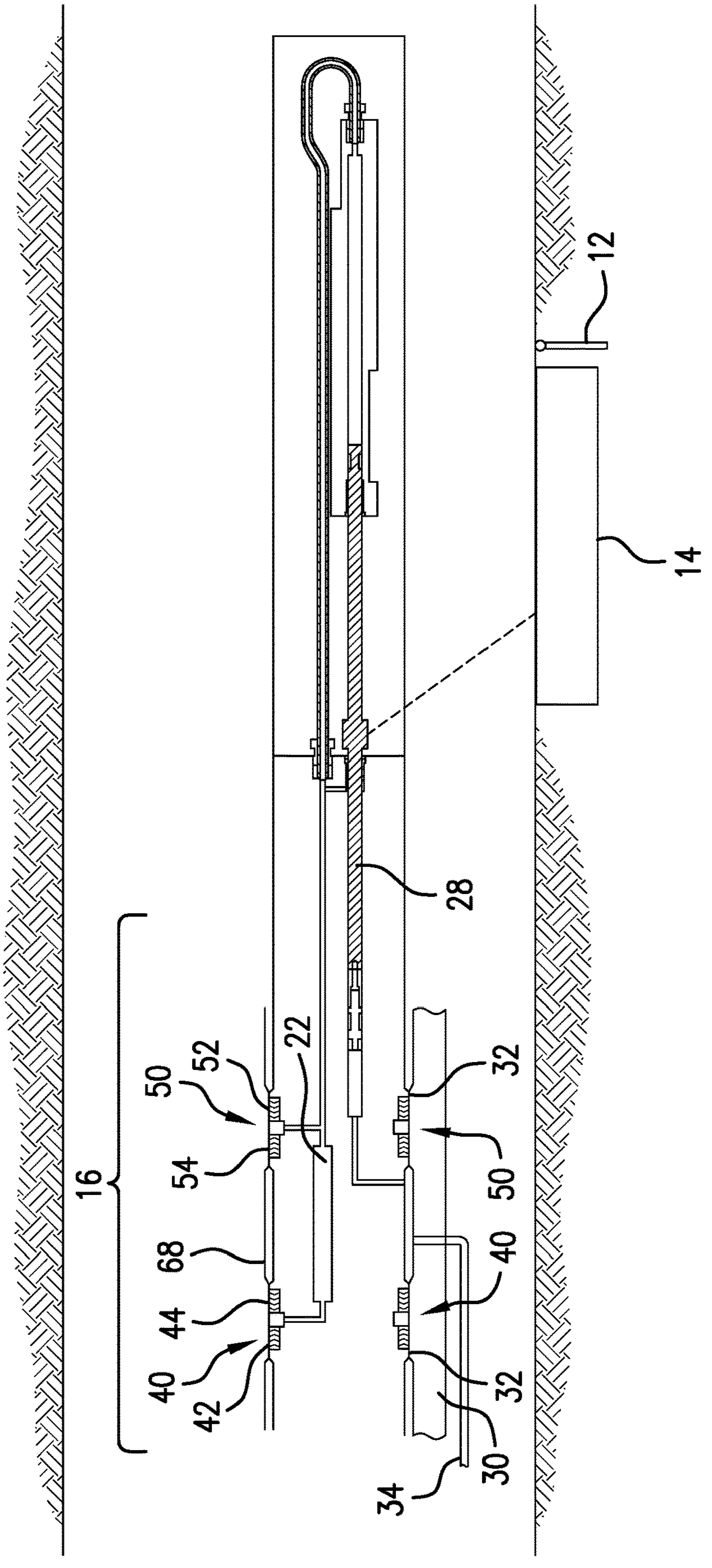

FIG. 2

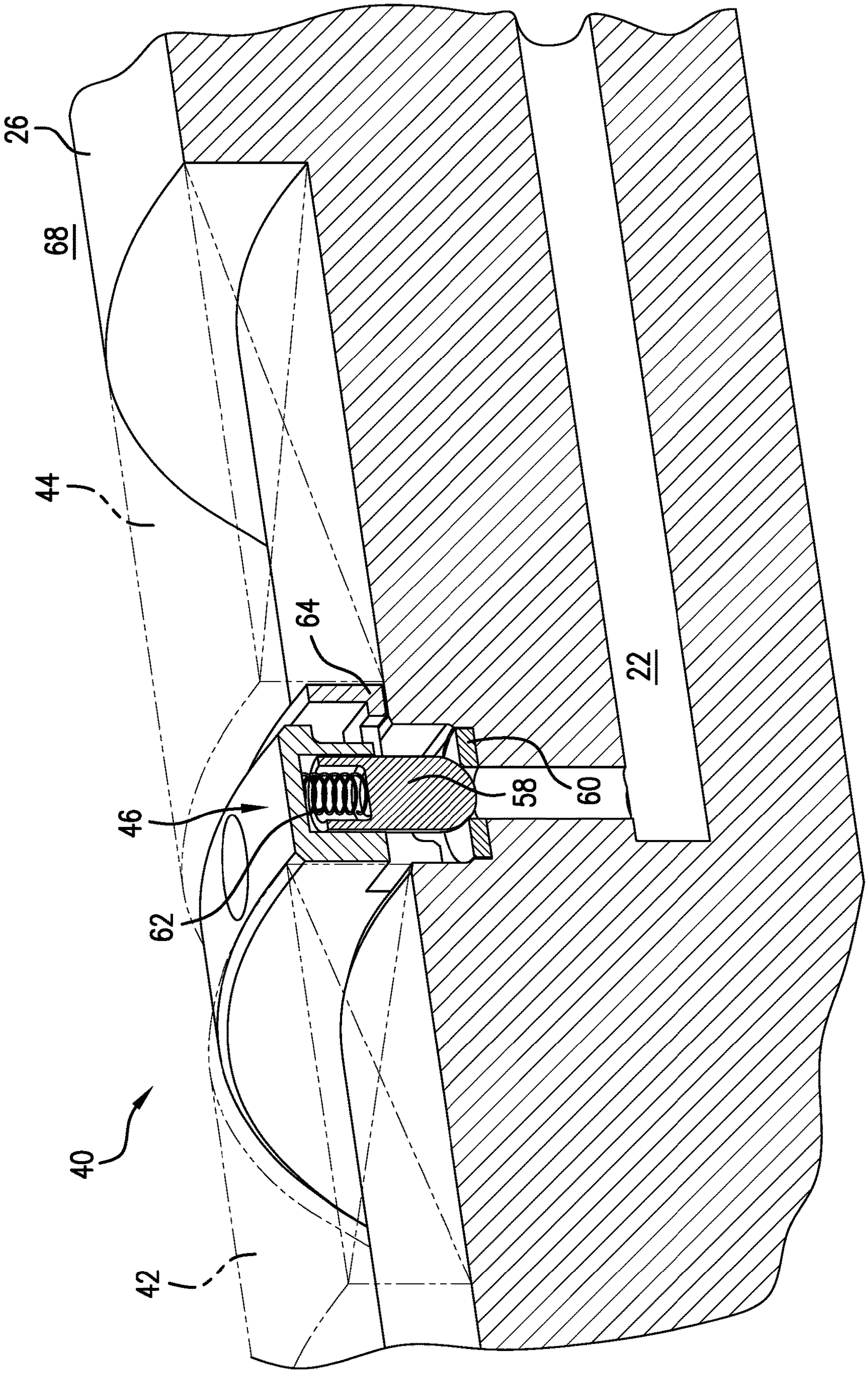

FIG.3

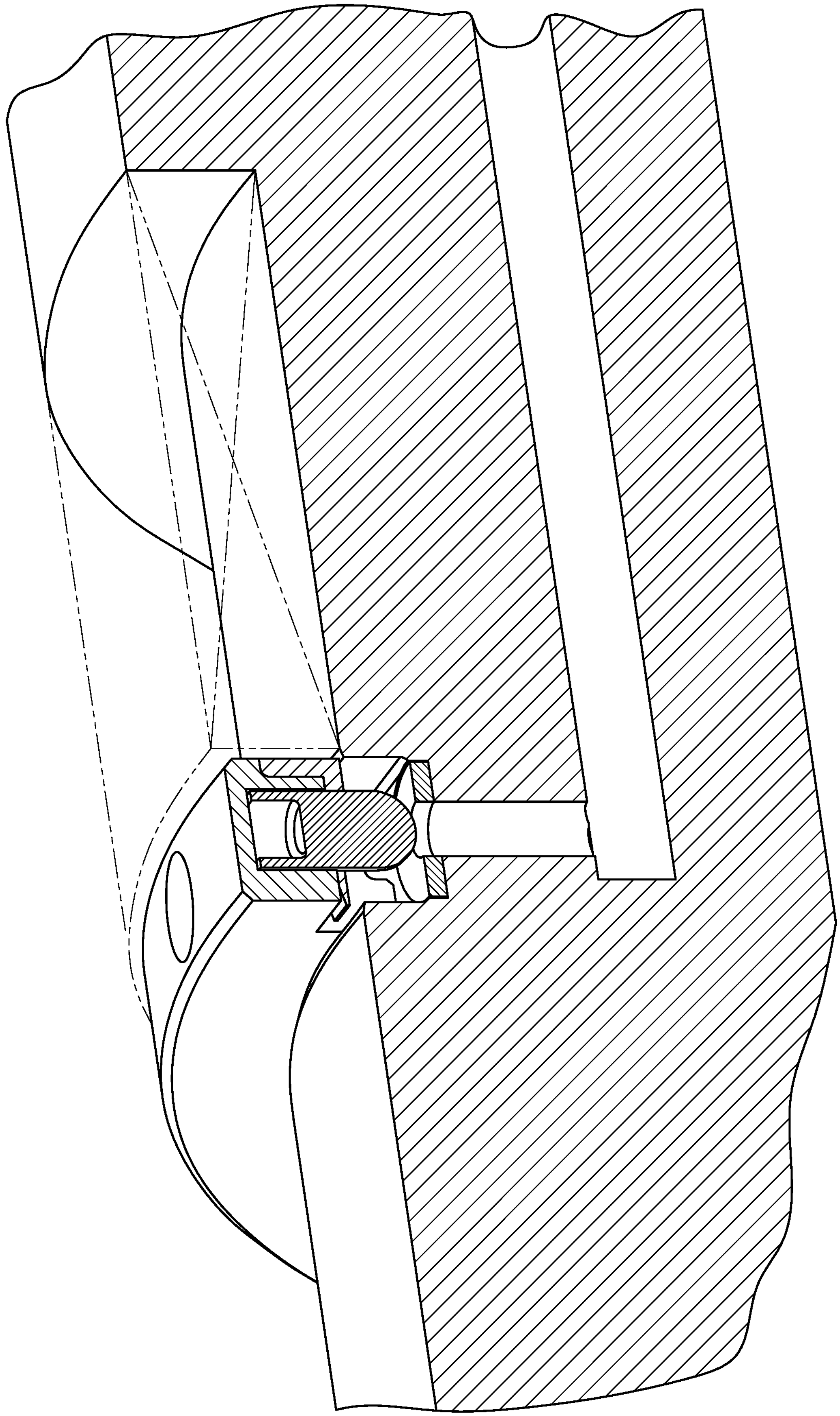

FIG.4

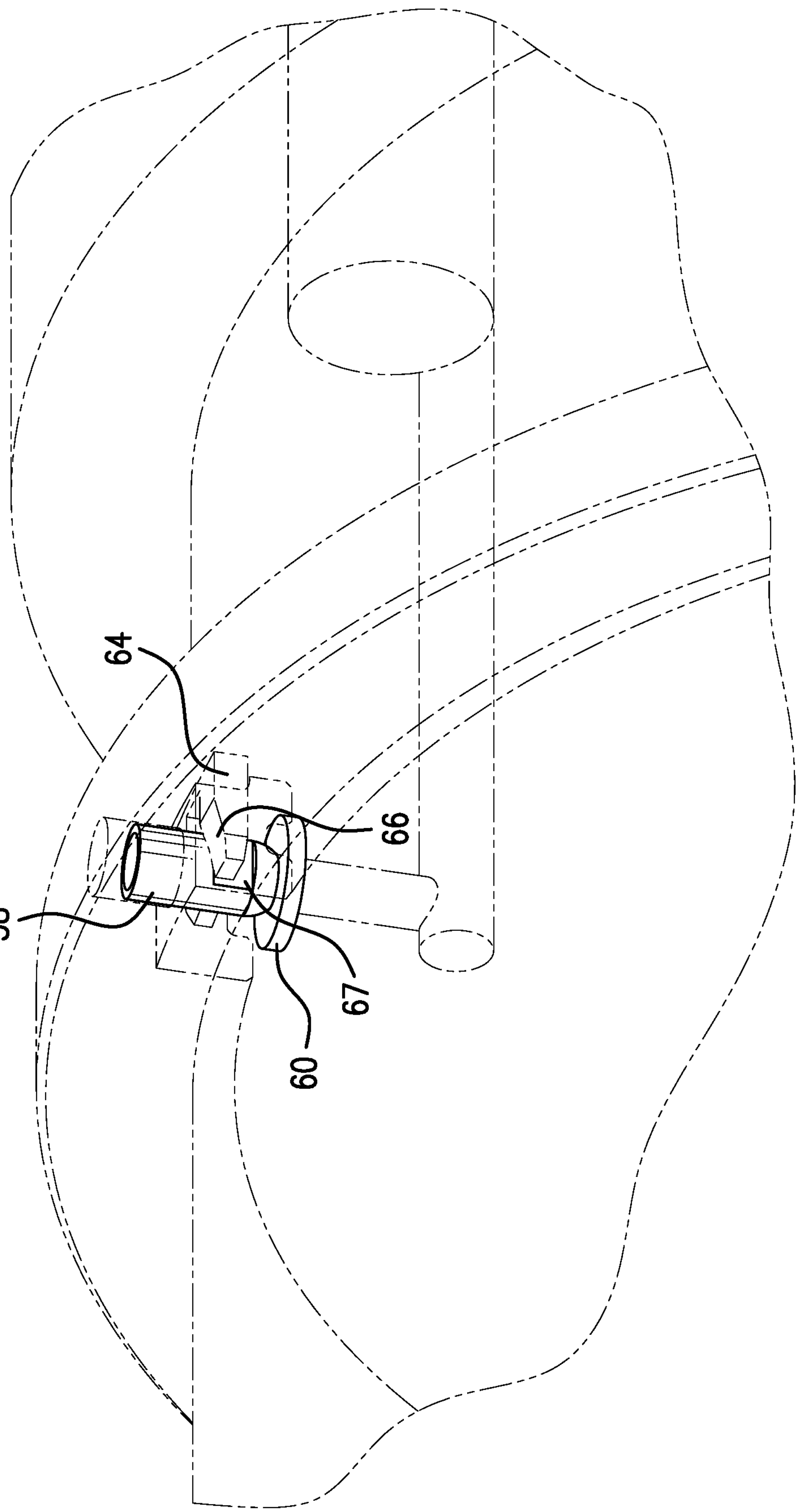

FIG.5

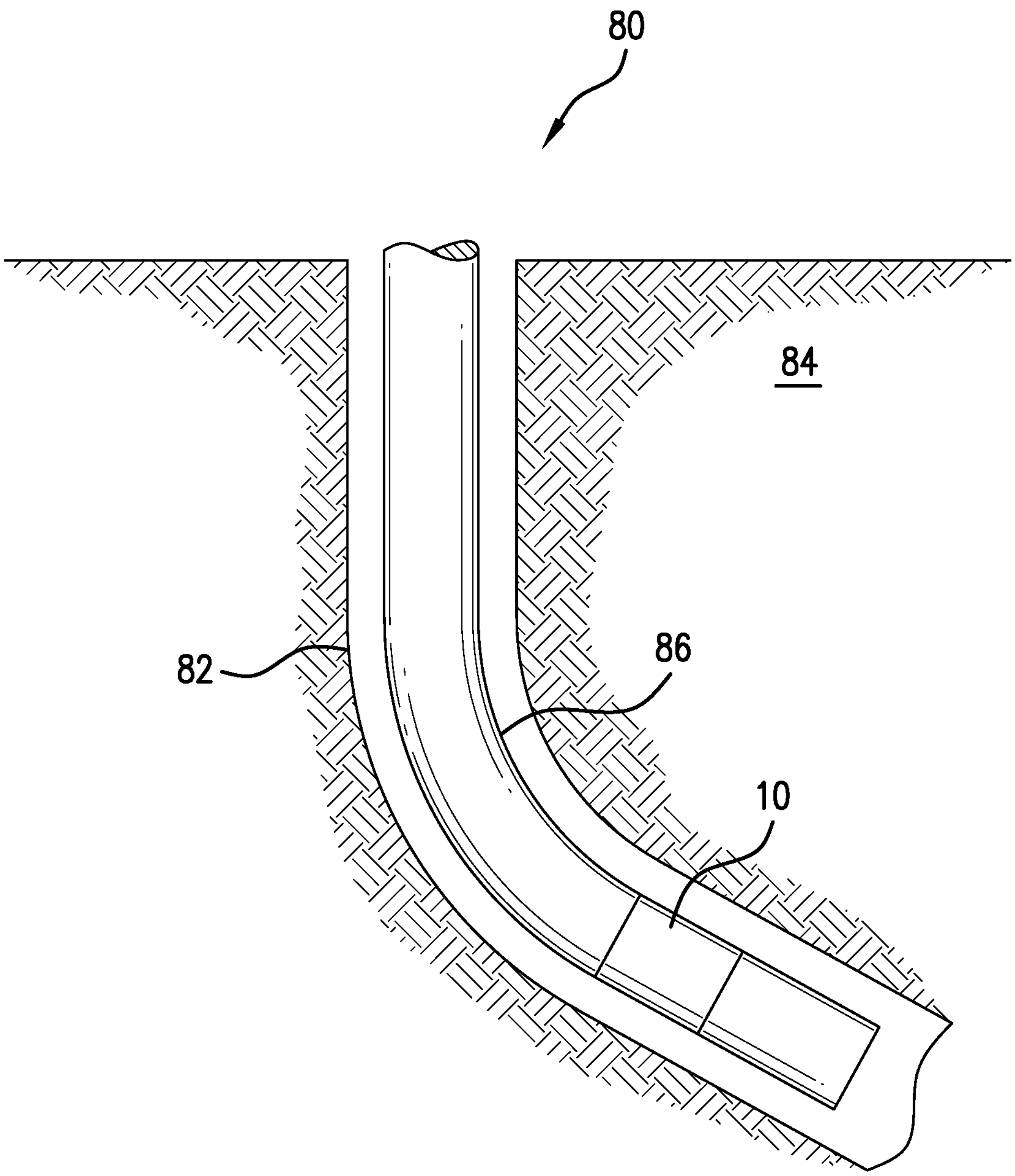

FIG.6

SAFETY VALVE, METHOD, AND SYSTEM

BACKGROUND

In the resource recovery and fluid sequestration industries safety valves are often employed for well control. Long service lives are paramount and yet sometimes the life of a safety valve is insufficient for the duty asked of it. In such conditions, insert safety valves are employed to substitute for the function of the previous safety valve. Axiomatically, disposing a replacement valve inside a previous valve reduces available inside diameter, which is generally contrary to desirability. Since insert valves are less expensive than complete workovers, they are not likely to disappear and hence new technologies with enhanced functionality are always desirable.

SUMMARY

An embodiment of an insert safety valve, including a housing, a flow tube movably disposed within the housing, a flapper articulated to the housing and responsive to positions of the flow tube relative to the housing, an atmospheric chamber disposed within the housing, a selectively openable valve disposed to prevent or allow pressure communication between the atmospheric chamber and an environment outside of the housing, the valve including a valve member, a valve seat, a biaser configured to urge the member against the seat, and an unseat member responsive to an external input to move the valve member off the valve seat.

An embodiment of a borehole system, including a preexisting safety valve having a control line, an insert safety valve, disposed within the preexisting safety valve, the insert safety valve configured to operate based upon input from the control line.

An embodiment of a method for controlling a wellbore, including running the insert safety valve to a location in a wellbore, preventing fluid communication with the atmospheric chamber of the safety valve during running, landing the insert safety valve, moving the unseat member, and enabling fluid communication with the atmospheric chamber.

An embodiment of a wellbore system, including a borehole in a subsurface formation, a string in the borehole, and an insert safety valve, disposed within or as a part of the string.

BRIEF DESCRIPTION OF THE DRAWINGS

The following descriptions should not be considered limiting in any way. With reference to the accompanying drawings, like elements are numbered alike:

FIG. **1** is a section view of an insert valve as disclosed herein;

FIG. **2** is a schematic view illustrating the control system of the insert valve of FIG. **1**;

FIG. **3** is a perspective view of a selectively openable valve fluidically associated with an atmospheric chamber of the valve of FIG. **1**, the openable valve in a closed position;

FIG. **4** is a perspective view of the selectively openable valve of FIG. **3**, the openable valve in an open position;

FIG. **5** is a perspective view of the openable valve **46** and related components; and

FIG. **6** is a view of a borehole system including the insert valve as disclosed herein.

DETAILED DESCRIPTION

A detailed description of one or more embodiments of the disclosed apparatus and method are presented herein by way of exemplification and not limitation with reference to the Figures.

Referring to FIG. **1**, a section view of an insert safety valve **10** is illustrated. Insert valve **10** includes a flapper **12**, a flow tube **14**, a control portion **16** configured to employ control line pressure from a preexisting control line **34** (see FIG. **2**) to operate the insert valve **10**. The insert valve **10** further includes an atmospheric chamber **22** to reduce actuation pressures required in ways known to the art. The chamber **22**, in order to function properly must be maintained free of wellbore fluid during the running process. For this purpose, a selectively openable valve **46/56** is disposed in a housing **26** of the insert valve **10** in fluid communication with the atmospheric chamber **22** and between chamber **22** and tubing pressure outside of the housing **26**. Atmospheric chamber **22** is also tasked with promoting a failsafe condition of the insert valve by causing the insert valve **10** to be unopenable if closed or to close if open in the event that pressure accesses the atmospheric chamber **22** other than simply by compressing the volume of the chamber **22** due to movement of a flow tube actuating piston **28**. Such pressure access is a result of liquid entering the chamber **22** from either a tubing pressure source or a control pressure source.

The insert valve **10** is run into the borehole to a preexisting safety valve **30** (see FIG. **2**). In most cases, preexisting valve **30** includes a seal bore **32** therein to accept and seal the insert valve **10** therein. The valve **30** will also have a provision for allowing access to the preexisting control line pressure. A preexisting control line **34** was in place to supply control pressure to the preexisting valve **30**. Various constructions and methods exist for accessing the original control line pressure and are known to the art.

Referring to FIGS. **2**, **3-5** for specifics and FIG. **1** for location, insert valve **10** includes a first packing arrangement **40**, having a tubing pressure side element **42** and a control pressure side element **44**. A selectively openable valve **46** is disposed between the element **42** and element **44**. The insert valve **10** also may comprise a second packing arrangement **50** having a tubing pressure side element **52** and a control pressure side element **54**. There also may be a second selectively openable valve **56** disposed between element **52** and element **54**. Openable valves **46** and/or **56** are configured with a valve member **58**, a valve seat **60**, a biaser **62**, and a valve unseat member **64**. The valve members **58** are initially seated in the valve seats **60** and prevent fluidic contact between the atmospheric chamber **22** and the environment outside of the insert valve **10**. Once the insert valve **10** is landed in the preexisting valve **30** however, the openable valves **46/56** need to be opened to support function of the insert valve **10**. Referring to FIG. **2**, the control line **34**, having been accessed by known methods, is available to provide pressure to a volume **68** between the insert valve **10** and the preexisting valve **30**, and bounded by the first and second packing arrangements **40** and **50**, respectively. Pressure applied to the volume **68** is control pressure that is controlled from a remote source by surface personnel or programmable controller. It is this pressure that is used to open the openable valves **46/56** and also to actuate the valve **10**. Accordingly, the valves **46/56** remain closed and protective of the chamber **22** until a decision is taken to open them through the application of pressure in the control line **34**. Pressurizing volume **68** causes one or both of the control side elements **44** and **54** will be moved along the housing **26** toward the unseat member **64**. In FIGS. **3** and **4**, only valve **46** is illustrated with surrounding structure. Valve **56** is a mirror image and so need not be detailed. Focusing on FIGS. **3** and **4**, the valve member **58** is seated on seat **60** and thereby allows no fluid communication between the atmospheric chamber **22** (fluidically the chamber **22** is all of the volume behind the valve member **58**) and the environment outside of the housing **26**. Upon the volume **68** being pressurized, element **44** is pushed leftwardly of the figure toward the valve **46**. Comparing FIGS. **3** and **4**, it will be appreciated that the valve member **58** and the unseat member **64** have changed position. The element **44** has pushed the unseat member **64** toward the valve member **58**. In the position of FIG. **4**, the unseat member **64** physically lifts the valve member **58** off the seat **60**. This can be seen in FIG. **4**. Referring to FIG. **5**, the unseat member **64** can be seen to exhibit a wedge **66** that engages a recess **67** of the valve member **58**. The urging of the unseat member **64** closer to the valve member **58** causes the valve member **58** to climb the wedge **66** and come off the seat **60**. Once off the seat, the chamber **22** is fluidly communicated to the space between element **42** and **44** bounded by the seal bore **32**. In this condition, the insert valve **10** may be operated via pressure from the control line. However, if packing **40** or **50** leaks in either direction (from the control side pressure or from the tubing pressure side) fluid will infiltrate the chamber **22** and either cause the valve **10** to close or prevent the opening of valve **10**. In either case, a leak past packing **40** or packing **50** in either direction (i.e., from the tubing pressure side or from the control pressure side) will allow fluid to move into the chamber **22** and thereby cause a fail-safe condition. The pathways implicated may be appreciated in schematic form in FIG. **2**, which includes the components discussed above and also illustrates the flow tube piston **28** that is to be actuated by the control line pressure in volume **68** to force the flow tube **14** to move into contact with the flapper **12** (both illustrated schematically in this figure). The entirety of the chamber **22** is illustrated and where atmospheric pressure is directed to enable function of the insert valve **10**.

In an embodiment hereof, the control portion **16** of the valve **10** requires more radial space in the housing **26** that a concentric bore for the flow tube **14** would support. Accordingly, insert valve **10** also includes an offset to the bore for the flow tube **14**. In an embodiment, the offset is about 0.250 inch. This is illustrated in FIG. **1**, where the deviation in the inside diameter of the valve **10** can be seen at deviation **70** and back at deviation **72**. This provides the additional space needed in the now eccentric annular space of the housing **26** on one side of the housing.

Referring to FIG. **6**, a borehole system **80** is illustrated. The system **80** comprises a borehole **82** in a subsurface formation **84**. A string **86** is disposed within the borehole **82**. An insert safety valve **10** as disclosed herein is disposed within or as a part of the string **86**.

Set forth below are some embodiments of the foregoing disclosure:

Embodiment 1: An insert safety valve, including a housing, a flow tube movably disposed within the housing, a flapper articulated to the housing and responsive to positions of the flow tube relative to the housing, an atmospheric chamber disposed within the housing, a selectively openable valve disposed to prevent or allow pressure communication between the atmospheric chamber and an environment outside of the housing, the valve including a valve member, a valve seat, a biaser configured to urge the member against the seat, and an unseat member responsive to an external input to move the valve member off the valve seat.

Embodiment 2: The safety valve as in any prior embodiment, wherein the valve member is a poppet.

Embodiment 3: The safety valve as in any prior embodiment, wherein the biaser is a compression spring.

Embodiment 4: The safety valve as in any prior embodiment, wherein the unseat member is a mechanical member that physically moves the valve member away from the valve seat.

Embodiment 5: The safety valve as in any prior embodiment, wherein the unseat member is responsive to pressure input.

Embodiment 6: The safety valve as in any prior embodiment, wherein the unseat member is responsive to a mechanical input.

Embodiment 7: The safety valve as in any prior embodiment, wherein the mechanical input is by a seal, the seal being movable based upon application of pressure.

Embodiment 8: The safety valve as in any prior embodiment, wherein the pressure is applied from a control location.

Embodiment 9: The safety valve as in any prior embodiment, wherein the housing further defines a bore for the flow tube that is offset from an axial centerline of the housing.

Embodiment 10: A borehole system, including a preexisting safety valve having a control line, an insert safety valve as in any prior embodiment, disposed within the preexisting safety valve, the insert safety valve configured to operate based upon input from the control line.

Embodiment 11: The borehole system as in any prior embodiment, wherein pressure from the control line is the external input.

Embodiment 12: The borehole system as in any prior embodiment, wherein pressure from the control line causes movement of a packing element disposed on the insert safety valve and adjacent the unseat member.

Embodiment 13: A method for controlling a wellbore, including running the insert safety valve as in any prior embodiment to a location in a wellbore, preventing fluid communication with the atmospheric chamber of the safety valve during running, landing the insert safety valve, moving the unseat member, and enabling fluid communication with the atmospheric chamber.

Embodiment 14: The method as in any prior embodiment, wherein the moving of the unseat member is by moving a packing disposed on the housing adjacent the unseat member.

Embodiment 15: The method as in any prior embodiment, wherein the moving the unseat member includes physically moving the valve member with the unseat member.

Embodiment 16: The method as in any prior embodiment, wherein the physically moving includes wedging.

Embodiment 17: A wellbore system, including a borehole in a subsurface formation, a string in the borehole, and an insert safety valve as in any prior embodiment, disposed within or as a part of the string.

The use of the terms "a" and "an" and "the" and similar referents in the context of describing the invention (especially in the context of the following claims) are to be construed to cover both the singular and the plural, unless otherwise indicated herein or clearly contradicted by context. Further, it should be noted that the terms "first," "second," and the like herein do not denote any order, quantity, or importance, but rather are used to distinguish one element from another. The terms "about", "substantially" and "generally" are intended to include the degree of error associated with measurement of the particular quantity based upon the equipment available at the time of filing the application. For example, "about" and/or "substantially" and/or "generally" can include a range of ±8% of a given value.

The teachings of the present disclosure may be used in a variety of well operations. These operations may involve using one or more treatment agents to treat a formation, the fluids resident in a formation, a borehole, and/or equipment in the borehole, such as production tubing. The treatment agents may be in the form of liquids, gases, solids, semi-solids, and mixtures thereof. Illustrative treatment agents include, but are not limited to, fracturing fluids, acids, steam, water, brine, anti-corrosion agents, cement, permeability modifiers, drilling muds, emulsifiers, demulsifiers, tracers, flow improvers etc. Illustrative well operations include, but are not limited to, hydraulic fracturing, stimulation, tracer injection, cleaning, acidizing, steam injection, water flooding, cementing, etc.

While the invention has been described with reference to an exemplary embodiment or embodiments, it will be understood by those skilled in the art that various changes may be made and equivalents may be substituted for elements thereof without departing from the scope of the invention. In addition, many modifications may be made to adapt a particular situation or material to the teachings of the invention without departing from the essential scope thereof. Therefore, it is intended that the invention not be limited to the particular embodiment disclosed as the best mode contemplated for carrying out this invention, but that the invention will include all embodiments falling within the scope of the claims. Also, in the drawings and the description, there have been disclosed exemplary embodiments of the invention and, although specific terms may have been employed, they are unless otherwise stated used in a generic and descriptive sense only and not for purposes of limitation, the scope of the invention therefore not being so limited.

What is claimed is:

1. An insert safety valve, comprising:
a housing;
a flow tube movably disposed within the housing;
a flapper articulated to the housing and responsive to positions of the flow tube relative to the housing;
a sealed atmospheric chamber disposed within the housing, the atmospheric chamber being initially sealed off from an environment outside of the housing;
a selectively openable valve disposed to prevent or allow pressure communication between the atmospheric chamber and an environment outside of the housing, the valve comprising:
a valve member;
a valve seat;
a biaser configured to urge the member against the seat; and
an unseat member responsive to an external input to move the valve member off the valve seat.

2. The safety valve as claimed in claim **1**, wherein the valve member is a poppet.

3. The safety valve as claimed in claim **1**, wherein the biaser is a compression spring.

4. The safety valve as claimed in claim **1**, wherein the unseat member is a mechanical member that physically moves the valve member away from the valve seat.

5. The safety valve as claimed in claim **1**, wherein the unseat member is responsive to pressure input.

6. The safety valve as claimed in claim **1**, wherein the unseat member is responsive to a mechanical input.

7. The safety valve as claimed in claim **6**, wherein the mechanical input is by a seal, the seal being movable based upon application of pressure.

8. The safety valve as claimed in claim **7**, wherein the pressure is applied from a control location.

9. The safety valve as claimed in claim **1**, wherein the housing further defines a bore for the flow tube that is offset from an axial centerline of the housing.

10. A wellbore system, comprising:
a borehole in a subsurface formation;
a string in the borehole; and
an insert safety valve as claimed in claim **1**, disposed within or as a part of the string.

11. A borehole system, comprising:
a preexisting safety valve having a control line;
an insert safety valve, comprising:
a housing;
a flow tube movably disposed within the housing;
a flapper articulated to the housing and responsive positions of the flow tube relative to the housing,
an atmospheric chamber disposed within the housing;
a selectively openable valve disposed to prevent or allow pressure communication between the atmospheric chamber and an environment outside of the housing, the valve comprising:
a valve member;
a valve seat;
an unseat member responsive to an external input to move the valve member off the valve seat,
the insert safety valve disposed within the preexisting safety valve, the insert safety valve configured to operate based upon input from the control line.

12. The borehole system as claimed in claim **11**, wherein pressure from the control line is the external input.

13. The borehole system as claimed in claim **11**, wherein pressure from the control line causes movement of a packing element disposed on the insert safety valve and adjacent the unseat member.

14. A method for controlling a wellbore, comprising:
running an insert safety valve, comprising:
a housing;
a flow tube movably disposed within the housing;
a flapper articulated to the housing and responsive to positions of the flow tube relative to the housing;
an atmospheric chamber disposed within the housing;
a selectively openable valve disposed to prevent or allow pressure communication between the atmospheric chamber and an environment outside of the housing, the valve comprising:
a valve member;
a valve seat;
an unseat member responsive to an external input to move the valve member off the valve seat,
to a location in a wellbore;
preventing fluid communication with the atmospheric chamber of the safety valve during running;
landing the insert safety valve;
moving the unseat member; and
enabling fluid communication with the atmospheric chamber.

15. The method as claimed in claim **14**, wherein the moving of the unseat member is by moving a packing disposed on the housing adjacent the unseat member.

16. The method as claimed in claim **14**, wherein the moving the unseat member includes physically moving the valve member with the unseat member.

17. The method as claimed in claim **16**, wherein the physically moving includes wedging.

* * * * *