an end of the flow tube; and a connecting assembly positioned between the flow tube and the piston assembly, the connecting assembly being configured to allow the flow tube to move toward the surface of the wellbore in response to a closing force exerted on the flow tube by the closing assembly and at least partially independent of movement toward the surface of the wellbore by at least part of the piston assembly; wherein the connecting assembly comprises a ring that is removably coupled to the flow tube, the ring comprising a first longitudinal end configured to couple with the piston assembly, the first longitudinal end having a first diameter and a second longitudinal end configured to couple with a power spring, the second longitudinal end having a second diameter larger than the first diameter, the second longitudinal end defining a boundary of a chamber configured to receive part of the flow tube as the flow tube moves toward the surface of the wellbore in response to the closing force~~.~~, wherein a take-up spring is disposed in the chamber, the take-up spring being normally biased away from the surface of wellbore.

[0008] According to a second aspect of the invention, a connecting assembly for a safety valve configured for being disposed in a wellbore through a fluid-producing formation is described, the connecting assembly comprising: a first end for coupling to a piston assembly and comprising a first diameter; a second end for engaging a power spring that supports the flow tube and comprising a second diameter larger than the first diameter, the second end defining a boundary of a chamber configured to receive

part of the flow tube; and a receiving member configured to allow the flow tube to move toward the surface of the wellbore and into the chamber in response to a closing force exerted on the flow tube by a flapper and at least partially independent of movement toward the surface of the wellbore by at least part of the piston assembly. The connecting assembly also includes a spring disposed in the chamber and is normally biased away from the surface of the wellbore.

[0009] According to a third aspect of the invention, a safety valve configured for being disposed in a wellbore through a fluid-producing formation is described, the safety valve comprising: a piston rod controlled by (i) a piston and (ii) hydraulic fluid introduced into the wellbore from the surface; a flow tube; a normally-closed flapper positioned proximate to an end of the flow tube for allowing and preventing fluid flow through the end of the flow tube; and a ring assembly positioned between the flow tube and the piston ~~assembly~~ rod and removably coupled to an exterior part of the flow tube, the ring assembly

configured to allow the flow tube to move toward the surface of the wellbore in response to a closing force exerted on the flow tube by the normally-closed flapper and at least partially independent of movement toward the surface of the wellbore by the piston rod, wherein the ring assembly comprises a first longitudinal end configured to couple with the pistol rod, the first longitudinal end having a first diameter and a second longitudinal end having a second diameter larger than the first diameter, the second longitudinal end defining a boundary of a chamber configured to receive part of the flow tube as the flow tube moves toward the surface of the wellbore in response to the closing force.—, wherein a take-up spring is disposed in the chamber, the take-up spring being normally biased away from the surface of the wellbore.

[0010] These illustrative aspects are mentioned not to limit or define the invention, but to provide examples to aid understanding of the inventive concepts disclosed. Other aspects, advantages, and features of the present invention will become apparent after review of the entire disclosure, figures, and claims.

Brief Description of the Drawings

[0011] Fig. 1 is a schematic illustration of a well system having a safety valve according to one aspect of the present invention.

[0012] Fig. 2 is a cross-sectional side view of the safety valve of Fig. 1 according to one aspect of the present invention.

[0013] Fig. 3 is a cross-sectional side view of part of the safety valve including a closing assembly of Fig. 1 according to one aspect of the present invention.

Claims

1. A safety valve configured for being disposed in a wellbore through a fluid-producing formation, the safety valve comprising:

a piston assembly controllable from a surface of the wellbore;

a flow tube;

a closing assembly for allowing and preventing fluid flow through an end of the flow tube; and

a connecting assembly positioned between the flow tube and the piston assembly, the connecting assembly being configured to allow the flow tube to move toward the surface of the wellbore in response to a closing force exerted on the flow tube by the closing assembly and at least partially independent of movement toward the surface of the wellbore by at least part of the piston assembly;

wherein the connecting assembly comprises a ring that is removably coupled to the flow tube, the ring comprising a first longitudinal end having a first diameter and a second longitudinal end having a second diameter larger than the first diameter, the second longitudinal end defining a boundary of a chamber configured to receive part of the flow tube as the flow tube moves toward the surface of the wellbore in response to the closing force.

2. The safety valve of claim 1, wherein the connecting assembly is configured to allow the flow tube to move toward the surface of the

wellbore at least partially independent of movement toward the surface of the wellbore by at least part of the piston assembly by allowing the flow tube to move more than a corresponding amount by which a piston rod of the piston assembly moves toward the surface.

3. The safety valve of claim 1, further comprising:

a power spring disposed external to the flow tube and configured for biasing the flow tube normally towards the surface of the wellbore,

wherein the piston assembly comprises:

a port for receiving hydraulic fluid from a control line;

a piston controllable by the hydraulic fluid introduced into the wellbore from the surface; and

a piston rod controllable by the piston,

wherein the ring is positioned external to the flow tube, coupled to the piston rod, and configured to engage the power spring;

wherein the connecting assembly comprises a take-up spring disposed in the chamber, the take-up spring being biased normally away from the surface of the wellbore; and

wherein the closing assembly comprises a normally-closed flapper positioned proximate to an end of the flow tube, the normally-closed flapper being configured to apply the closing force to the flow tube.

4. The safety valve of claim 3, wherein the ring is coupled to the piston rod by coupling mechanisms, the safety valve further comprising gaps between the coupling mechanisms and the ring, wherein the gaps are configured to allow the piston rod to move at least partially independent to the ring.

5. The safety valve of claim 1, wherein the connecting assembly is configured to allow the flow tube to move toward the surface of the wellbore by one-half inch or more at least partially independent of movement toward the surface of the wellbore by at least part of the piston assembly.

6. The safety valve of claim 1, wherein the connecting assembly is configured to allow the flow tube to move toward the surface of the wellbore by an amount that is in a range of one inch to six inches at least partially independent of movement toward the surface of the wellbore by at least part of the piston assembly.

7. The safety valve of claim 1, wherein the connecting assembly comprises:

a take-up spring disposed in the chamber, the take-up spring being biased normally away from the surface of the wellbore and configured for being compressed by the flow tube in response to the closing force and in response to the flow tube moving at least partially independent to movement by the piston assembly.

8. The safety valve of claim 1, wherein: the first longitudinal end is coupled to the piston assembly;

the second longitudinal end is configured to engage a power spring that supports the flow tube; and

the ring is configured to allow the flow tube to move toward the surface of the wellbore in response to the closing force exerted on the flow tube by a flapper and at least partially independent of movement toward the surface of the wellbore by at least part of the piston assembly.

9. A connecting assembly for a safety valve configured for being disposed in a wellbore through a fluid-producing formation, the connecting assembly comprising:

a first end for coupling to a piston assembly and comprising a first diameter;

a second end for engaging a power spring that supports a flow tube and comprising a second diameter larger than the first diameter, the second end defining a boundary of a chamber configured to receive part of the flow tube; and

a receiving member configured to allow the flow tube to move toward the surface of the wellbore and into the chamber in response to a closing force exerted on the flow tube by a flapper and at least partially independent of movement toward the surface of the wellbore by at least part of the piston assembly.

10. The connecting assembly of claim 9, further comprising:

a ring comprising the first end and the second end, the ring being configured for defining the receiving member; and

a spring disposed in the receiving member, the spring being configured for being biased normally away from the surface of the wellbore and configured for being compressed by the flow tube in response to the closing force and in response to the flow tube moving at least partially independent to movement by the piston assembly.

11. The connecting assembly of claim 9, wherein the receiving member is configured to allow the flow tube to move toward the surface of the wellbore at least partially independent of movement toward the surface of the wellbore by at least part of the piston assembly by allowing the flow tube to move more than a corresponding amount by which a piston rod of the piston assembly moves toward the surface.

12. The connecting assembly of claim 9, wherein the receiving member is configured to allow the flow tube to move toward the surface of the wellbore by one-half inches or more at least partially independent of movement toward the surface of the wellbore by at least part of the piston assembly.

13. The connecting assembly of claim 9, wherein the connecting assembly is configured to allow the flow tube to move toward the surface

of the wellbore by an amount that is in a range of one inch to six inches at least partially independent of movement toward the surface of the wellbore by at least part of the piston assembly.

14. The connecting assembly of claim 9, wherein the first end comprises openings configured to receive part of the piston assembly,

wherein the second end comprises a raised boss.

15. A safety valve configured for being disposed in a wellbore through a fluid-producing formation, the safety valve comprising:

a piston rod controllable by (i) a piston and (ii) hydraulic fluid introduced into the wellbore from the surface;

a flow tube;

a normally-closed flapper positioned proximate to an end of the flow tube for allowing and preventing fluid flow through the end of the flow tube; and

a ring assembly positioned between the flow tube and the piston assembly and removably coupled to an exterior part of the flow tube, the ring assembly being configured to allow the flow tube to move toward the surface of the wellbore in response to a closing force exerted on the flow tube by the normally-closed flapper and at least partially independent of movement toward the surface of the wellbore by the piston rod,

wherein the ring assembly comprises a first longitudinal end having a first diameter and a second longitudinal end having a second diameter

larger than the first diameter, the second longitudinal end defining a boundary of a chamber configured to receive part of the flow tube as the flow tube moves toward the surface of the wellbore in response to the closing force.

16. The safety valve of claim 15, wherein the ring assembly is configured to allow the flow tube to move toward the surface of the wellbore at least partially independent of movement toward the surface of the wellbore by the piston rod by allowing the flow tube to move more than a corresponding amount by which a piston rod of the piston assembly moves toward the surface.

17. The safety valve of claim 15, further comprising:

a power spring disposed external to the flow tube and configured for biasing the flow tube normally towards the surface of the wellbore,

a port for receiving hydraulic fluid from a control line; and

a piston controllable by the hydraulic fluid introduced into the wellbore from the surface, the piston rod being controllable by the piston,

wherein the ring assembly is coupled to the piston rod and configured to engage the power spring;

wherein a take-up spring is disposed in the chamber, the take-up spring being biased normally away from the surface of the wellbore; and

wherein the ring assembly is coupled to the piston rod by coupling mechanisms, the safety valve further comprising gaps between the coupling mechanisms and the ring assembly, wherein the gaps are configured to allow the piston rod to move at least partially independent to the ring assembly.

18. The safety valve of claim 15, wherein the ring assembly is configured to allow the flow tube to move toward the surface of the wellbore by one-half inches or more at least partially independent of movement toward the surface of the wellbore by the piston rod.

19. The safety valve of claim 15, wherein the ring assembly is configured to allow the flow tube to move toward the surface of the wellbore by an amount that is in a range of one inch to six inches at least partially independent of movement toward the surface of the wellbore by the piston rod.

20. The safety valve of claim 15, wherein the ring assembly comprises:

a take-up spring disposed in the chamber, the take-up spring being biased normally away from the surface of the wellbore and configured for being compressed by the flow tube in response to the closing force and in response to the flow tube moving at least partially independent to movement by the piston rod.

CLAIMS

1. A safety valve configured for being disposed in a wellbore through a fluid-producing formation, the safety valve comprising:

a piston assembly controllable from a surface of the wellbore;

a flow tube;

a closing assembly for allowing and preventing fluid flow through an end of the flow tube; and

a connecting assembly positioned between the flow tube and the piston assembly, the connecting assembly being configured to allow the flow tube to move toward the surface of the wellbore in response to a closing force exerted on the flow tube by the closing assembly and at least partially independent of movement toward the surface of the wellbore by at least part of the piston assembly;

wherein the connecting assembly comprises a ring that is removably coupled to the flow tube, the ring comprising a first longitudinal end configured to couple with the piston assembly and a second longitudinal end configured to couple with a power spring, the first longitudinal end having a first diameter and a second longitudinal end having a second diameter larger than the first diameter, the second longitudinal end defining a boundary of a chamber configured to receive part of the flow tube as the flow tube moves toward the surface of the wellbore in response to the closing force, wherein a take-up spring is

disposed in the chamber, the take-up spring being normally biased away from the surface of the wellbore.

2. The safety valve of claim 1, wherein the connecting assembly is configured to allow the flow tube to move toward the surface of the wellbore at least partially independent of movement toward the surface of the wellbore by at least part of the piston assembly by allowing the flow tube to move more than a corresponding amount by which a piston rod of the piston assembly moves toward the surface.

3. The safety valve of claim 1, further comprising:

the power spring disposed external to the flow tube and configured for biasing the flow tube normally towards the surface of the wellbore,

wherein the piston assembly comprises:

a port for receiving hydraulic fluid from a control line;

a piston controllable by the hydraulic fluid introduced into the wellbore from the surface; and

a piston rod controllable by the piston,

wherein the ring is positioned external to the flow tube, coupled to the piston rod, and configured to engage the power spring;

and

wherein the closing assembly comprises a normally-closed flapper positioned proximate to an end of the flow tube, the normally-closed flapper being configured to apply the closing force to the flow tube.

4. The safety valve of claim 3, wherein the ring is coupled to the piston rod by coupling mechanisms, the safety valve further comprising gaps between the coupling mechanisms and the ring, wherein the gaps are configured to allow the piston rod to move at least partially independent to the ring.

5. The safety valve of claim 1, wherein the connecting assembly is configured to allow the flow tube to move toward the surface of the wellbore by one-half inch or more at least partially independent of movement toward the surface of the wellbore by at least part of the piston assembly.

6. The safety valve of claim 1, wherein the connecting assembly is configured to allow the flow tube to move toward the surface of the wellbore by an amount that is in a range of one inch to six inches at least partially independent of movement toward the surface of the wellbore by at least part of the piston assembly.

7. The safety valve of claim 1, wherein the take-up spring is configured for being compressed by the flow tube in response to the closing force and in response to the flow tube moving at least partially independent to movement by the piston assembly.

8. The safety valve of claim 1, wherein:

the first longitudinal end is coupled to the piston assembly;

the second longitudinal end is coupled to the power spring that supports the flow tube; and

the ring is configured to allow the flow tube to move toward the surface of the wellbore in response to the closing force exerted on the flow tube by a flapper and at least partially independent of movement toward the surface of the wellbore by at least part of the piston assembly.

9. A connecting assembly for a safety valve configured for being disposed in a wellbore through a fluid-producing formation, the connecting assembly comprising:

a first end for coupling to a piston assembly and comprising a first diameter;

a second end for engaging a power spring that supports a flow tube and comprising a second diameter larger than the first diameter, the second end defining a boundary of a chamber configured to receive part of the flow tube;

a spring disposed in the chamber and being normally biased away from the surface of the wellbore; and

a receiving member configured to allow the flow tube to move toward the surface of the wellbore and into the chamber in response to a closing force exerted on the flow tube by a flapper and at least partially independent of movement toward the surface of the wellbore by at least part of the piston assembly.

10. The connecting assembly of claim 9, further comprising:

a ring comprising the first end and the second end, the ring being configured for defining the receiving member;

wherein the spring is configured for being compressed by the flow tube in response to the closing force and in response to the flow tube moving at least partially independent to movement by the piston assembly.

11. The connecting assembly of claim 9, wherein the receiving member is configured to allow the flow tube to move toward the surface of the wellbore at least partially independent of movement toward the surface of the wellbore by at least part of the piston assembly by allowing the flow tube to move more than a corresponding amount by which a piston rod of the piston assembly moves toward the surface.

12. The connecting assembly of claim 9, wherein the receiving member is configured to allow the flow tube to move toward the surface of the wellbore by one-half inches or more at least partially independent of movement toward the surface of the wellbore by at least part of the piston assembly.

13. The connecting assembly of claim 9, wherein the connecting assembly is configured to allow the flow tube to move toward the surface of the wellbore by an amount that is in a range of one inch to six inches at least partially independent of movement toward the surface of the wellbore by at least part of the piston assembly.

14. The connecting assembly of claim 9, wherein the first end comprises openings configured to receive part of the piston assembly,

wherein the second end comprises a raised boss.

15. A safety valve configured for being disposed in a wellbore through a fluid-producing formation, the safety valve comprising:

a piston rod controllable by (i) a piston and (ii) hydraulic fluid introduced into the wellbore from the surface;

a flow tube;

a normally-closed flapper positioned proximate to an end of the flow tube for allowing and preventing fluid flow through the end of the flow tube; and

a ring assembly positioned between the flow tube and the piston rod and removably coupled to an exterior part of the flow tube, the ring assembly being configured to allow the flow tube to move toward the surface of the wellbore in response to a closing force exerted on the flow tube by the normally-closed flapper and at least partially independent of movement toward the surface of the wellbore by the piston rod,

wherein the ring assembly comprises a first longitudinal end configured to couple with the piston rod and a second longitudinal end configured to couple with a power spring, the first longitudinal end having a first diameter and a second longitudinal end having a second diameter larger than the first diameter, the second longitudinal end defining a boundary of a chamber configured to receive part of the flow tube as the flow tube moves toward the surface of the wellbore in response to the closing force, wherein a take-up spring is disposed in the chamber, the take-up spring being normally biased away from the surface of the wellbore.

16. The safety valve of claim 15, wherein the ring assembly is configured to allow the flow tube to move toward the surface of the wellbore at least partially independent of movement toward the surface of the wellbore by the piston rod by allowing the flow tube

to move more than a corresponding amount by which a piston rod of the piston assembly moves toward the surface.

17. The safety valve of claim 15, further comprising:

the power spring disposed external to the flow tube and configured for biasing the flow tube normally towards the surface of the wellbore,

a port for receiving hydraulic fluid from a control line; and

a piston controllable by the hydraulic fluid introduced into the wellbore from the surface, the piston rod being controllable by the piston,

wherein the ring assembly is coupled to the piston rod and configured to engage the power spring;

and

wherein the ring assembly is coupled to the piston rod by coupling mechanisms, the safety valve further comprising gaps between the coupling mechanisms and the ring assembly, wherein the gaps are configured to allow the piston rod to move at least partially independent to the ring assembly.

18. The safety valve of claim 15, wherein the ring assembly is configured to allow the flow tube to move toward the surface of the wellbore by one-half inches or more at least partially independent of movement toward the surface of the wellbore by the piston rod.

19. The safety valve of claim 15, wherein the ring assembly is configured to allow the flow tube to move toward the surface of the wellbore by an amount that is in a range of one inch to six inches at least partially independent of movement toward the surface of the wellbore by the piston rod.

20. The safety valve of claim 15, wherein the take-up spring is configured for being compressed by the flow tube in response to the closing force and in response to the flow tube moving at least partially independent to movement by the piston rod.