Claims

1. A valve actuator comprising:

a movable control element moveable in a longitudinal direction;

a propulsion device for moving said movable control element, the propulsion device comprising a moveable portion moveable in a longitudinal direction having a stroke extending from a first position to a second position;

a resilient element, having a stroke extending in a longitudinal direction from a first relatively unloaded position to a second relatively loaded position; and,

a transmission mechanism;

the resilient element being loaded in the longitudinal direction under the action of the propulsion device via the transmission mechanism and being configured to urge the moveable portion of the propulsion device in the longitudinal direction towards the first position via the transmission mechanism when loaded;

wherein the transmission mechanism provides a gearing ratio between the moveable portion of the propulsion device and the resilient element;

wherein the transmission mechanism is configured to vary the gearing ratio between the moveable portion of the propulsion device and the resilient element within the stroke of the moveable portion of the propulsion device;

wherein the transmission mechanism is characterised by:-

a pivotable lever arm having one end pivotally coupled around a pivot point to an outer structure of the valve actuator and another end, and further comprising a surface which engages with the moveable portion; and

an arm linkage which is pivotally coupled to the lever arm at a separate point on the lever arm between the said one end and the other end where said separate point is spaced apart from the said pivot point;

wherein movement of the moveable portion in the longitudinal direction causes the lever arm to pivot around the said pivot point which causes the arm linkage to move in the longitudinal direction and which is translated to smaller longitudinal movement of the resilient element.

2. A valve actuator as claimed in claim 1, further comprising an anti-rotation plate which in use resists unwanted rotation of the transmission mechanism.

3. A valve actuator as claimed in claim 1, wherein the moveable portion of the propulsion device follows the said surface of the lever arm, and the said surface of the lever arm is shaped to transmit additional force at a particular point in the stroke of the moveable portion of the propulsion device.

4. A valve actuator as claimed in any preceding claim, wherein the transmission mechanism is configured to provide a gearing reduction ratio between the moveable portion of the propulsion device and the resilient element, within the stroke of the moveable portion of the propulsion device.

5. A valve actuator as claimed in claim 4, wherein the gearing reduction ratio is reduced as the resilient element nears one end of its stroke, that is between 50% and 95% of the distance through its stroke.

6. A valve actuator as claimed in claim either claim 4 or 5, wherein the gearing reduction ratio is reduced as the resilient element is close to the first relatively unloaded position, that is more than 70% of the distance through its stroke towards the relatively unloaded position.

7. A valve actuator as claimed in claim 4, wherein the gearing reduction ratio is increased as the resilient element nears one end of its stroke, that is between 50% and 95% of the distance through its stroke.

8. A valve actuator as claimed in claim 4 or claim 7, wherein the gearing reduction ratio is increased as the resilient element is close to the second relatively loaded position, that is more than 70% of the distance through its stroke towards the relatively loaded position.

9. A valve actuator as claimed in claim 8, wherein the lever arm and moveable portion of the propulsion device engage via a roller.

10. A valve actuator as claimed in any preceding claim, wherein a notch and/or shoulder is/are provided on the said surface of the lever arm so that a relatively steep gradient exists on the said surface of the lever arm.

11. A valve actuator as claimed in any preceding claim, wherein the resilient element is compressed by the lever arm in a direction opposite the direction of movement of the moveable portion of the propulsion device.

12. A valve actuator as claimed in any of claims 1 to 10, wherein the resilient element is compressed by the lever arm in the same direction as

the direction of movement of the moveable portion of the propulsion device.

13. A valve actuator according to any preceding claim, wherein the propulsion device is a piston and cylinder arrangement.

14. A valve actuator according to claim 13 wherein the moveable portion of the propulsion device is a cylinder.

15. A valve actuator according to claim 14 wherein the cylinder is disposed around said piston and a cylinder sleeve disposed around said cylinder.

16. A valve actuator according to claim 15 wherein said piston and cylinder sleeve are joined, providing an annular gap or volume for receiving the cylinder.

17. A valve actuator according to either of claims 15 or 16 wherein said piston and cylinder sleeve may be selectively decoupled to allow for selective relative movement of the two.

18. A valve actuator according to any preceding claim wherein the resilient element is disposed around the outside of the propulsion device.

19. A valve actuator according to any preceding claim wherein the resilient element is a spring.

20. A valve actuator according to any preceding claim wherein the resilient element comprises a stack of disc springs.

21. A valve actuator according to any preceding claim wherein the resilient element is attached to a first plate at its first end and a second plate at its second end and wherein said first plate is moveable and said second plate is fixed.

22. A valve including a valve actuator according to any preceding claim.

23. A pipeline including at least one valve according to claim 22.

Claims

1. A valve actuator comprising:

a movable control element;

a propulsion device for moving said movable control element, the propulsion device comprising a moveable portion having a stroke extending from a first position to a second position;

a resilient element, having a stroke extending from a first relatively unloaded position to a second relatively loaded position; and,

a transmission mechanism;

the resilient element being loaded under the action of the propulsion device via the transmission mechanism and being configured to urge the moveable portion of the propulsion device towards the first position via the transmission mechanism when loaded;

wherein the transmission mechanism provides a gearing ratio between the moveable portion of the propulsion device and the resilient element.

2. A valve actuator as claimed in claim 1, wherein the transmission mechanism is configured to vary the gearing ratio between the moveable portion of the propulsion device and the resilient element, within the stroke of the moveable portion of the propulsion device.

3. A valve actuator as claimed in claim 1 or claim 2, wherein the transmission mechanism is configured to provide a gearing reduction ratio between the moveable portion of the propulsion device and the resilient element, within the stroke of the moveable portion of the propulsion device.

4. A valve actuator as claimed in any preceding claim, wherein the gearing reduction ratio is reduced as the resilient element nears one end of its stroke, that is between 50% and 95% of the distance through its stroke.

5. A valve actuator as claimed in any preceding claim, wherein the gearing reduction ratio is reduced as the resilient element is close to the first relatively unloaded position, that is more than 70% of the distance through its stroke towards the relatively unloaded position.

6. A valve actuator as claimed in claim 1 or claim 2, wherein the gearing reduction ratio is increased as the resilient element nears one end of its stroke, that is between 50% and 95% of the distance through its stroke.

7. A valve actuator as claimed in claim 1 or claim 2 or claim 6, wherein the gearing reduction ratio is increased as the resilient element is close to the second relatively loaded position, that is more than 70% of the distance through its stroke towards the relatively loaded position.

8. A valve actuator as claimed in any preceding claim, wherein the transmission mechanism comprises a lever.

9. A valve actuator as claimed in claim 8, wherein the lever and moveable portion of the propulsion device engage via a roller.

10. A valve actuator as claimed in claim 8 or 9, wherein the moveable portion of the propulsion device follows the shape of the lever, and the lever is shaped to transmit additional force at a particular point in the stroke of the moveable portion of the propulsion device.

11. A valve actuator as claimed in any one of claims 8 to 10, wherein a notch and/or shoulder is/are provided on the lever so that a relatively steep gradient exists on the surface of the lever.

12. A valve actuator as claimed in any of claims 8 to 11, wherein the resilient element is compressed by the lever in a direction opposite the direction of movement of the moveable portion of the propulsion device.

13. A valve actuator as claimed in any of claims 8 to 11, wherein the resilient element is compressed by the lever in the same direction as the direction of movement of the moveable portion of the propulsion device.

14. A valve actuator as claimed in any one of claims 1 to 7, wherein the transmission device comprises a rack and pinion mechanism, with the pinion engaged in the rack.

15. A valve actuator as claimed in claim 14, wherein the rack is connected to the movable portion of the propulsion device, an axle extends through the pinion and the axle engages with the resilient element.

16. A valve actuator as claimed in claim 15, wherein the axle is provided in the pinion in an off-centre position.

17. A valve actuator as claimed in any one of claims 14 to 16 wherein a second static rack is provided engaged with the pinion.

18. A valve actuator according to any preceding claim, wherein the propulsion device is a piston and cylinder arrangement.

19. A valve actuator according to claim 18 wherein the moveable portion of the propulsion device is a cylinder.

20. A valve actuator according to either of claims 18 or 19 wherein the cylinder is disposed around said piston and a cylinder sleeve disposed around said cylinder.

21. A valve actuator according to claim 20 wherein said piston and cylinder sleeve are joined, providing an annular gap or volume for receiving the cylinder.

22. A valve actuator according to either of claims 20 or 21 wherein said piston and cylinder sleeve may be selectively decoupled to allow for selective relative movement of the two.

23. A valve actuator according to any preceding claim wherein the resilient element is disposed around the outside of the propulsion device.

24. A valve actuator according to any preceding claim wherein the resilient element is a spring.

25. A valve actuator according to any preceding claim wherein the resilient element comprises a stack of disc springs.

26. A valve actuator according to any preceding claim wherein the resilient element is attached to a first plate at its first end and a second plate at its second end and wherein said first plate is moveable and said second plate is fixed.

27. A valve including a valve actuator according any preceding claim.

28. A pipeline including at least one valve according claim 27.

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