

APPLICATION FOR PATENT

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Title: Springless Compressor Valve

FIELD OF THE INVENTION

5 [0001] The field of this invention is valves particularly valves that cycle frequently and actuators for them operate without springs.

BACKGROUND OF THE INVENTION

[0002] Compressor valves come in a variety of designs and are powered open by differential pressure and in the typical known design use some type of a spring to
10 push the valve to the close position. The main issue with such designs is spring fatigue and failure after a predetermined number of cycles. Thus the problem addressed by the present invention is to present a valve design that can provide an economical construction and a reliably long service life. That objective is accomplished by elimination of the spring and the use of a force that preferably has a
15 longer life cycle by using components that are less affected or better withstand the cycling that is the duty of a valve particularly one in a compressor application. In a preferred embodiment, the closing force is provided by the alignment of like poles of permanent magnets. Other embodiments are contemplated that deliver a closing force through a device that is not prone to fatigue or wear as would be experienced in an
20 application involving a spring.

[0003] In many applications outside of compressor valves not only have springs been used but they have been combined with electromagnets to create an opening force against a spring return. Hydraulic pistons can also be used in conjunction with springs. These variations are all suggested in related U.S. Patents 4,799,507 and
25 4,869,289. Other examples of electromagnets or permanent magnets for solenoid

valves and valve actuators and other applications are U.S. Patents 6,179,268;
6,532,919; and 5,356,211. U.S. Patent 6,799,746 relies on a spring inside the valve to
return an actuating piston to an original position in response to movement induced by
an electromagnet. In yet other applications, such as a door closer in U.S. Patent
5 4,670,939 a magnet moves a ball that acts as a valve member to control the flow of
hydraulic fluid when controlling the closing and opening of a door. U.S. Patent
5,366,506 shows an intraurethral valve with a magnetic valve member that can be
selectively opened to allow urine to pass by moving another magnet from outside the
body. The following patents show the general state of the art of compressor valves:
10 U.S. Patents 6,810,901; 6,790,018; 6,751,941; 6,684,651; 6,644,945; 6,585,500;
6,152,710; 5,947,708; 5,885,062; 5,547,344; 5,025,828; 4,793,779 and 4,446,608.

[0004] What is needed, particularly in a compressor application where a reciprocating
compressor that runs at 300- 1800 RPM and has valves that cycle between 5-20 times
per second corresponding to that speed is a more reliable closing force that improves
15 on the service life seen from coil springs or plate type closing springs. While the
preferred embodiment is to use neodymium-iron-boron permanent magnets with
similar poles facing, those skilled in the art will appreciate the full scope of the
invention from the specification and claims, which appear below.

SUMMARY OF THE INVENTION

20 **[0005]** A valve closure system particularly suited to reciprocating compressors
employs no springs and preferably urges the valve in the closed direction by the force
generated from magnets positioned to repel each other and in that manner deliver the
force to keep the compressor valve closed. Other applications are envisioned and
different techniques for replacing the spring component in such valve assemblies are
25 also contemplated.

DETAILED DESCRIPTION OF THE DRAWINGS

[0006] Figure 1 is a section view of a magnet driven closure for a concentric ring type valve in a compressor;

[0007] Figure 2 is a section view of a magnet driven closure for a ported plate styled
5 valve in a compressor;

[0008] Figure 3 is a section view of a magnet driven closure for a poppet styled valve in a compressor; and

[0009] Figure 4 is a section view of a magnet driven closure for a ring styled valve which uses either a single ring or a multitude of identical rings (not concentric) in a
10 compressor.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0010] Referring to Figure 1, the seat **10** has passages **12** that lead to a seating surface **14**. Flow represented by arrow **16** progresses on pressure buildup to push against the
15 valve member **18** to displace it from seating surface **14**, whereupon the flow passes through guard **20** through passages **22** as represented by arrow **24**. Aligned with the valve member **18** and extending in guard **20** is a small bore **26** leading into a bigger bore **28**. A shoe **30** having a bore **32** is secured or mounted in bore **28**. A magnet **34** that has a bore **36** aligned in fluid communication with bore **32** is mounted in shoe **30**.
20 A button **38** rides over a portion of the shoe **30** and is slidably retained to it to limit its stroke and to keep the two from being detached in ported plate and ring valves. In poppet valves shown in Figure 3, there is no button; instead, a magnet is mounted directly in the poppet, and is not slidably retained. A magnet **40** is mounted to the button **38** in such a manner that the orientations of magnets **34** and **40** is such that
25 like poles face each other creating a repelling force that is overcome by rising

pressure in passages **12** to get the valve member **18** off of seating surface **14**. The valve member **18** can be any one of a number of designs. A concentric ring design is illustrated in Figure 1 and a ported plate design is shown in Figure 2, a poppet valve is shown in Figure 3, and a ring, either single ring or multiple same size non-concentric rings for the valve member **18** is shown in Figure 4. In all other respects the illustrated embodiments of Figures 1 and 2 and 4 work in the same way. The embodiment also works the same way, but there is no button (magnet is in poppet) in Figure 3, and the poppet is not slidably retained.

[0011] Those skilled in the art will appreciate that the springs on valves particularly in compressor applications can be eliminated using the magnets. The magnets can be permanent or electromagnets or combinations of both. The magnets represent the preferred execution of the invention that comprises the elimination of springs to close the valves. Other solutions to replace the springs in such valves are particularly employing forces that can be delivered over a physical gap without mechanical contact are all within the scope of the invention. Therefore solutions that employ various fields to span a gap or that employ fluid pressure optionally in conjunction with accumulators are all within the scope of the invention.

[0012] It is to be understood that this disclosure is merely illustrative of the presently preferred embodiments of the invention and that no limitations are intended other than as described in the appended claims.

CLAIMS

The invention claimed is:

1. A fluid-handling system, comprising: a poppet comprising: a body, comprising a head having a sealing surface configured to seal against a seating surface, and a leg extending from a downstream side of the head; a magnet; and a mounting member configured to secure the magnet to the body; wherein the leg has a generally tubular shape that defines an interior volume in which both the magnet and the mounting member are disposed.
2. The system of claim 1, wherein the sealing surface defines a generally frusto-conical volume.
3. The system of claim 1, wherein the mounting member comprises an elastically deformable member configured to secure the magnet to the body.
4. The system of claim 1, wherein the mounting member comprises threads configured to secure the mounting member to the body.
5. The system of claim 1, wherein the mounting member comprises a plastically-deformable member configured to secure the magnet to the mounting member.
6. The system of claim 1, comprising an adhesive disposed between the magnet and the mounting member.
7. The system of claim 1, wherein: the body is a one-piece body made of a material that includes plastic, wherein the leg is a tubular leg, and wherein both the head and the tubular leg are rotationally symmetric about the same axis; the mounting member includes metal and comprises: a plurality of plastically deformable members extending from an upstream side of the mounting member; a generally circular-tubular sidewall with exterior threads configured to secure the mounting member to complementary threads disposed inside a tubular portion of the head; and a downstream restraint having a tool interface configured to receive torque from a tool; and the magnet is disposed within the circular-tubular sidewall of the mounting member, between the plurality of plastically deformable members and the downstream restraint.
8. The system of claim 1, comprising: a seat having an intake passage with a seating surface, wherein the seat is disposed upstream from poppet; a shoe disposed downstream from the poppet and having a repelling magnet; a guard having a shoe receptacle in which the shoe is disposed and an outlet passage.
9. The system of claim 8, wherein the shoe comprises a shock absorber.
10. The system of claim 8, wherein the shoe, the repelling magnet, and the guard have a fluid-drainage aperture.
11. The system of claim 8, comprising a compressor having a compression cylinder in fluid communication with the intake passage and a driver coupled to a piston disposed within the compression cylinder.
12. A valve, comprising: a poppet comprising: a magnet, wherein a downstream side of the magnet is substantially wider than an upstream side of the magnet; and a body disposed about the magnet, wherein the body includes a head and a leg that defines a distal surface that is downstream from the magnet.
13. The valve of claim 12, wherein the leg defines a generally frusto-conical, interior volume.

14. The valve of claim 12, comprising a shelf disposed adjacent a downstream side of the magnet.

15. The valve of claim 14, wherein the shelf includes a fillet on a downstream side of the shelf, where the shelf meets the leg.

16. The valve of claim 12, comprising a plurality of poppet receptacles and a plurality of poppets, wherein the plurality of poppets are configured to translate within a respective poppet receptacle.

17. A method of forming a valve, the method comprising: providing a poppet body for a valve; providing a magnet; providing a mounting member configured to attach the magnet to the poppet body; and providing a shelf adjacent a downstream side of the magnet.

18. The method of claim 17, wherein providing the poppet body comprises injection molding the poppet body.

19. The method of claim 17, comprising: inserting the magnet into the mounting member; and after inserting the magnet, attaching the mounting member to the poppet body.

20. The method of claim 19, wherein attaching the mounting member to the poppet body comprises engaging threads on the poppet body with complementary threads on the mounting member.

21. An apparatus, comprising: a compressor; and a valve disposed between a fluid inlet and a fluid outlet of the compressor, wherein the valve comprises: a valve member, comprising a poppet; a mounting member coupled to the valve member; and a magnet coupled to the valve member by the mounting member; wherein the poppet comprises a leg, and wherein the mounting member is disposed between the magnet and the leg.

22. The apparatus of claim 21, wherein the compressor comprises a piston.

23. A fluid-handling system, comprising: a poppet comprising: a body; a magnet; a mounting member configured to secure the magnet to the body; and an adhesive disposed between the magnet and the mounting member.

24. The system of claim 23, wherein: the body is a one-piece body made of a material that includes plastic, and wherein the body includes both a head with a sealing surface and a tubular leg extending from the downstream side of the head, wherein both the head and the tubular leg are rotationally symmetric about the same axis; the mounting member includes metal and comprises: a plurality of plastically deformable members extending from an upstream side of the mounting member; a generally circular-tubular sidewall with exterior threads configured to secure the mounting member to complementary threads disposed inside a tubular portion of the head; and a downstream restraint having a tool interface configured to receive torque from a tool; and the magnet is disposed within the circular-tubular sidewall of the mounting member, between the plurality of plastically deformable members and the downstream restraint.

25. The system of claim 23, comprising: a seat having an intake passage with a seating surface, wherein the seat is disposed upstream from poppet; a shoe disposed downstream from the poppet and having a repelling magnet; and a guard having a shoe receptacle in which the shoe is disposed and an outlet passage.

26. A fluid-handling system, comprising: a poppet comprising: a one-piece body made of a material that includes plastic, and wherein the body includes both a head with a sealing surface and a tubular leg extending from a downstream side of the head, wherein both the head and the tubular leg are rotationally symmetric about the same axis; a magnet; and a mounting member configured to secure the magnet to the body, wherein the mounting member includes metal and

comprises: a plurality of plastically deformable members extending from an upstream side of the mounting member; a generally circular-tubular sidewall with exterior threads configured to secure the mounting member to complementary threads disposed inside a tubular portion of the head; and a downstream restraint having a tool interface configured to receive torque from a tool; and wherein the magnet is disposed within the circular-tubular sidewall of the mounting member, between the plurality of plastically deformable members and the downstream restraint.

27. The system of claim 26, comprising: a seat having an intake passage with a seating surface, wherein the seat is disposed upstream from poppet; a shoe disposed downstream from the poppet and having a repelling magnet; and a guard having a shoe receptacle in which the shoe is disposed and an outlet passage.

28. The system of claim 27, comprising an adhesive disposed between the magnet and the mounting member.

29. A fluid-handling system, comprising: a poppet comprising: a body; a magnet; and a mounting member configured to secure the magnet to the body; a seat having an intake passage with a seating surface, wherein the seat is disposed upstream from poppet; a shoe disposed downstream from the poppet and having a repelling magnet; and a guard having a shoe receptacle in which the shoe is disposed and an outlet passage.

30. A valve, comprising: a poppet comprising: a magnet; a body disposed about the magnet, wherein the body includes a head and a leg that defines a distal surface that is downstream from the magnet; and a shelf disposed adjacent a downstream side of the magnet.