Magnetic Coupler with Force Balancing

Background

[0001] This section is intended to provide relevant background information to facilitate a better understanding of the various aspects of the described embodiments. Accordingly, it should be understood that these statements are to be read in this light and not as admissions of prior art.

[0002] Magnetic couplers are used to translate motion between physical barriers, in which a drive magnet is located on one side of the barrier and a follower magnet is located on the other side. The drive magnet is coupled to an actuator which moves the drive magnet, and the drive magnet induces movement in the follower magnet through magnetic coupling. The follower magnet then moves another element or device to carry out the intended function. Devices with magnetic couplers, such as valves, are often used in oil and gas operations, in which the device may come into contact with various fluids and chemicals that may be potentially detrimental to the device over time. Magnetic couplers allow sensitive components such as actuators and electronics to be contained and isolated from the fluids while still carrying out the device function through actuation of the follower magnet.

[0003] The drive magnet and the follower magnet of a magnetic coupler are attracted to each other and exert an attractive magnet force on each other. This is what enables magnetic coupling. However, the constant pull strains the structural assemblies of the magnets, such as bearings and other components.

Summary

[0003a] According to a first aspect of the present disclosure, there is provided a magnetic coupling system, including: a drive magnet; a follower magnet magnetically coupled to the drive magnet, wherein movement of the drive magnet induces corresponding movement of the follower magnet; a magnetic balancing component separate from the drive magnet and located to a side of the follower magnet, wherein the magnetic balancing component and the drive magnet each separately exert attractive magnetic forces on the follower magnet in opposite directions; a housing comprising a drive chamber in

which the drive magnet is located; a follower chamber isolated from the drive chamber and in which the follower magnet is located; and a balancing chamber separate from the drive chamber and in which the magnetic balancing component is located.

[0003b] According to a second aspect of the present disclosure, there is provided a magnetically coupled actuation system, including: a drive actuator; a drive magnet coupled to and movable by the actuator; a follower magnet isolated from and magnetically coupled to the drive magnet, wherein movement of the drive magnet induces corresponding movement of the follower magnet; a follower device coupled to and driven by movement of the follower magnet; a magnetic balancing component separate from the drive magnet and located to a side of the follower magnet opposite the drive magnet, wherein the magnetic balancing component and the drive magnet each separately exert attractive magnetic forces on the follower magnet in opposite directions, a housing comprising a drive chamber in which the drive magnet is located; a follower chamber isolated from the drive chamber and in which the follower magnet is located; and a balancing chamber separate from the drive chamber and in which the magnetic balancing component is located.

[0003c] According to a third aspect of the present disclosure, there is provided a method of balancing a magnetic coupler, including: locating a magnetic balancing component separate from the drive magnet and in a balancing chamber to a side of a follower magnet opposite a drive magnet located in a housing comprising a drive chamber, wherein the follower magnet is located in a follower chamber isolated from the drive chamber and is magnetically coupled to the drive magnet; exerting attractive magnetic forces separately by each of the magnetic balancing component and the drive magnet on the follower magnet in opposite directions.

Brief Description of the Drawings

[0004] For a detailed description of the embodiments of the invention, reference will now be made to the accompanying drawings in which:

Claims

1. A magnetic coupling system, comprising:

a drive magnet;

a follower magnet magnetically coupled to the drive magnet, wherein movement of the drive magnet induces corresponding movement of the follower magnet;

a magnetic balancing component separate from the drive magnet and located to a side of the follower magnet, wherein the magnetic balancing component and the drive magnet each separately exert attractive magnetic forces on the follower magnet in opposite directions;

a housing comprising a drive chamber in which the drive magnet is located;

a follower chamber isolated from the drive chamber and in which the follower magnet is located; and

a balancing chamber separate from the drive chamber and in which the magnetic balancing component is located.

2. The system of claim 1, wherein the magnetic balancing component is located to the side of the follower magnet opposite the drive magnet.

3. The system of claim 1, wherein the magnetic balancing component is located to the side of the drive magnet.

4. The system of claim 1, wherein the drive magnet is coupled to and movable via an actuator.

5. The system of claim 4, wherein the actuator comprises at least one of an electrical system, a mechanical system, a hydraulic system, a pneumatic system, or any combination thereof.

6. The system of claim 1, wherein the follower magnet is coupled to an actuable element movable by movement of the follower magnet.

7. The system of claim 6, wherein the actuable element is a valve.

8. The system of claim 1, wherein a linear movement of the drive magnet induces linear movement of the follower magnet.

9. The system of claim 1, wherein rotational movement of the drive magnet induces rotational movement of the follower magnet.

10. The system of claim 9, wherein the drive magnet is coupled to and driven by a turbine and the follower magnet is coupled to and actuates a generator

11. The system of claim 10, wherein a physical barrier is located between the drive chamber and the follower chamber.

12. The system of claim 1, wherein each of the drive magnet and the follower magnet comprises a Halbach array.

13. A magnetically coupled actuation system, comprising:

a drive actuator;

a drive magnet coupled to and movable by the actuator;

a follower magnet isolated from and magnetically coupled to the drive magnet, wherein movement of the drive magnet induces corresponding movement of the follower magnet;

a follower device coupled to and driven by movement of the follower magnet;

a magnetic balancing component separate from the drive magnet and located to a side of the follower magnet opposite the drive magnet, wherein the magnetic balancing component and the drive magnet each separately exert attractive magnetic forces on the follower magnet in opposite directions;

a housing comprising a drive chamber in which the drive magnet is located;

a follower chamber isolated from the drive chamber and in which the follower magnet is located; and

a balancing chamber separate from the drive chamber and in which the magnetic balancing component is located.

14. The system of claim 13, wherein the follower device is connected to and moveable to open and close a valve.

15. The system of claim 13, wherein rotational movement of the drive magnet induces rotational movement of the follower magnet.

16. The system of claim 13, wherein a linear movement of the drive magnet induces linear movement of the follower magnet.

17. The system of claim 13, wherein each of the drive magnet and the follower magnet comprises a Halbach array.

18. A method of balancing a magnetic coupler, comprising:

locating a magnetic balancing component separate from the drive magnet and in a balancing chamber to a side of a follower magnet opposite a drive magnet located in a housing comprising a drive chamber, wherein the follower magnet is located in a follower chamber isolated from the drive chamber and is magnetically coupled to the drive magnet;

exerting attractive magnetic forces separately by each of the magnetic balancing component and the drive magnet on the follower magnet in opposite directions.

19. The method of claim 18, further comprising moving the drive magnet and inducing movement in the follower magnet via movement of the drive magnet.

20. The method of claim 19, further comprising actuating a valve via movement of the follower magnet.