United States Patent

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[54] **PERMANENT MAGNET VALVE WITH MAGNETIC OPERATOR**
3 Claims, 4 Drawing Figs.

[52] **U.S. Cl.** **251/65,** 251/129
[51] **Int. Cl.** **F16k 31/08**
[50] **Field of Search** 251/65, 75, 129

[56] **References Cited**

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ABSTRACT: Valving means including a valving member which is movable between open and closed positions, and which is actuated between said positions by the respective interaction and noninteraction of two magnetic fields having axes that are disposed at an angle with respect to one another.

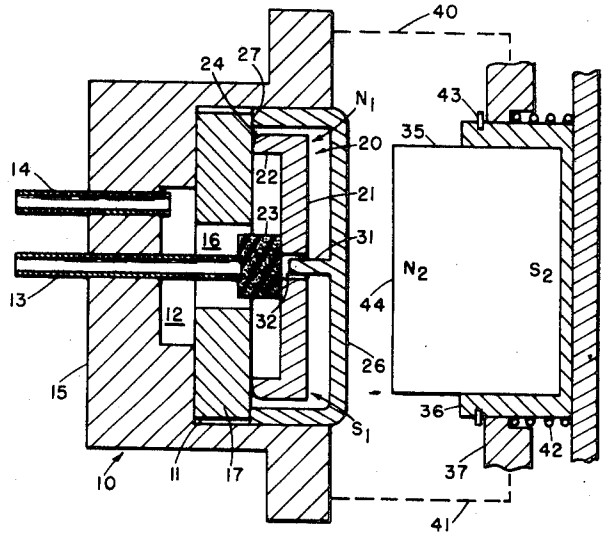


Fig. 1

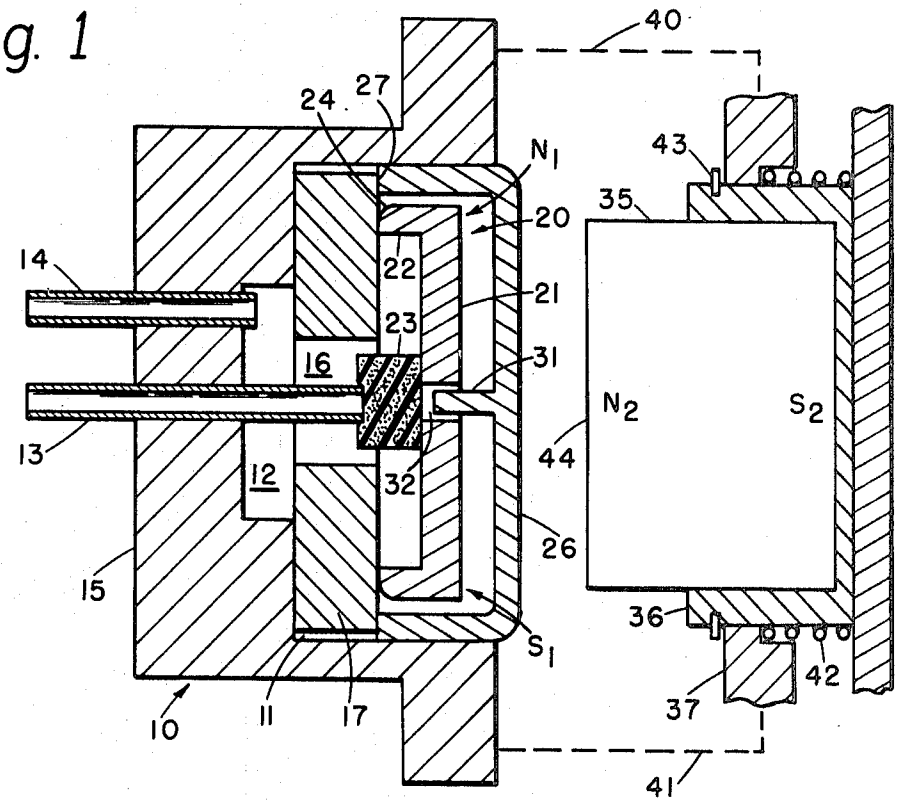
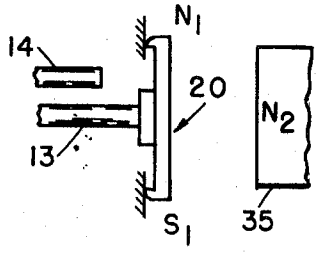


Fig. 3



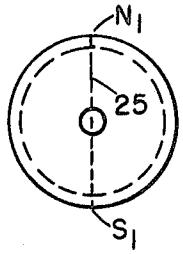


Fig. 2

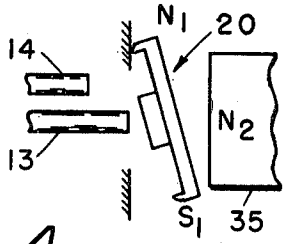


Fig. 4

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PERMANENT MAGNET VALVE WITH MAGNETIC OPERATOR

This invention relates to a novel pneumatic valving arrangement. More particularly the invention relates to a novel valving system wherein a movable valve member is actuated between its two operative positions by a particular application of two magnetic fields and is supported in a particular manner for such actuation.

In many fields, such as fluidic controls and logic systems, there is a need for an on-off type of fluid control valve which is very simple, has a very low cost and is capable of reliably operating at very high speeds over long periods of use. Further, this type of valve must be capable of working without the possibility of external foreign elements becoming ingested in the valving system and must have an effective "rise" time in the order of 1 to 2 milliseconds and should exhibit a snap action in its valving shift operation. Conventional devices have satisfied one or more of these requirements however there is little, if any, presently available equipment which is capable of affording all the advantages named. The instant valving arrangement contemplates a system wherein all the above traits are exhibited.

The primary object of the instant invention is to provide a novel, fast-acting, low-cost, snap-action type of valve arrangement.

Another object of the invention is to provide the novel valve arrangement wherein a movement of the valving member is produced by utilizing the magnetic attractive and repulsive forces generated by two interacting magnetic fields.

A further object of the invention is to provide a novel valving means having a valving member that is disposed in a sealed chamber so as to prevent any external foreign particles or contaminants from reaching the valving surfaces and may be pivoted in a particular manner for movement between two operative positions.

Still another object of the invention is to provide a novel valving action wherein the valving member is adapted to pivot about one side thereof, the pivotal movement being produced by a magnetic repulsive force acting adjacent said one side of the valving member and a magnetic attractive force acting adjacent an opposed side of the valving member.

Other objects of the invention will become apparent as the disclosure progresses.

IN THE DRAWINGS:

FIG. 1 is an axial sectional view of the instant valving arrangement.

FIG. 2 is an axial view of the valve disc of the instant valving arrangement.

FIGS. 3 and 4 are diagrammatic views illustrating the operative nature of the instant apparatus.

Referring to FIG. 1, there is shown a main body member 10 of general cylindrical configuration and having formed therein a cylindrical chamber 11; a centrally located recess 12 being provided in the bottom of said chamber 11. A fluid inlet tube or line 14 and a fluid outlet tube or line 13 respectively communicate with said recess 12 and chamber 11; each of these tubes or lines being defined by any suitable tubular fitting which is suitably sealed in the end wall 15 of said main body 10. The bevelled inner end of the central outlet 13 is disposed within the center orifice 16 of an annular member or washer 17 which is disposed in the bottom of the chamber 11 and which is made from iron or other magnetizable material. A valving member 20 is disposed within said chamber 11 and comprises the disc 21 having a peripheral flange 22 extending in an axial direction and having a resilient valve sealing member or pad 23 that is centrally secured to the inner face thereof. The outer end portion of the disc flange 22 is formed with an arcuate surface as indicated at 24, this arcuate surface facilitating the swinging or pivoting of the valve disc 21 about one side thereof so as to thereby move said valve pad 23 into and out of fluid flow impeding or blocking engagement with the said inner end of outlet line 13. The disc 21 comprises a permanent magnet which is magnetized so that the axis of the magnetic field thereof is disposed along a substantially diametral line 25, as indicated in FIG. 2, or in a plane including said line or substantially parallel thereto; thereby resulting in the north magnetic pole N_1 and the south magnetic pole S_1 thereof being disposed on opposite sides of, or at the ends of the diameter of, disc 21. In the normal condition of the valve assembly, the magnetic field of disc 21 in combination with the ferromagnetic washer 17 causes the valving member 20 to be continuously magnetically biased towards and into peripheral contact with the member 17 so that the valving pad 23 is thereby moved to and yieldably held in sealing engagement with the inner end of said outlet tube 13 as shown in FIG. 1. Thus in this normal condition of the valving arrangement fluid flow through lines 13 and 14 is effectively blocked or impeded.

The chamber 11 is adapted to be sealed off from the surrounding medium by means of a cup-shaped cover 26 which is forced into and tightly frictionally retained in the otherwise open end of chamber 11 opposite from the element 17 so as to thereby prevent any external foreign particles or contaminants from entering the chamber 11 once the latter is sealed. The inner end 27 of cover 26 holds element 17 in place as shown, while the inner face thereof is provided with an axially extending integral center pin 31 that is adapted to project into the slightly enlarged central hole 32 formed in the valve disc 21. This pin and hole arrangement 31, 32 will keep the valving member 20 in general coaxial alignment with the inlet conduit 13 while permitting the said swinging movement of the valve disc about one side thereof.

The means for pivotally actuating the valving member 20 comprises a permanent magnet 35 which is suitably mounted on and secured to a support member or plunger 36 which in turn is axially slidably mounted in a suitable housing 37, the latter being structurally connected in any suitable manner with the main body member 10 as indicated by the dotted lines 40, 41. The magnet 35 preferably is square in cross section and has a cross-sectional area that is approximately equal to the area of the adjacent face of the valve disc 21. The support member 36 is normally biased by means of a suitable spring 42 to an outer position determined by engagement of the retaining clip 43 disposed on member 36 with the inner face of the housing 37. As will be apparent various different means may be used to mount magnet 35.

The plunger or support member 36 is adapted to be moved by any external or other force in an inward direction against the biasing action of spring 42 so that the magnetic pole at the inner end 44 of magnet 35 moves relatively close to valve disc 21. Upon release of the support plunger 36 the spring 42 will restore the plunger 36 and the magnet 35 to the normal outer position shown wherein the said magnet end 44 is relatively remote from the valve disc 21. These operative inner and outer positions of the magnet 35 are located such that when in the said outer position the magnetic fields of the respective magnetic elements 35 and 21 do not effectively interact, while when in the said inner position thereof the magnetic fields of the two elements 35 and 21 do effectively interact. For the purpose of illustration and discussion here, let it be assumed that the upper portion of the valve disc 21, as seen in FIG. 1, constitutes the north magnetic pole N_1 of the disc and that the lower diametrically opposed end of the disc 21 constitutes the south magnetic pole S_1 of the disc; and that the left end of the magnetic element 35, as seen in FIG. 1, is the north magnetic pole N_2 thereof while the right hand or opposite end thereof is the south magnetic pole S_2 thereof. When the magnetic element 35 is in its said outer position the fields of the respective magnets do not interact as noted above and hence the valve disc 21 remains yieldably retained against the ferromagnetic washer element 17 and fluid flow through lines 13 and 14 is thus effectively blocked. When, however, the magnetic element 35 is in its said inner position the magnetic field of the magnet 35 will interact with the magnetic field of element 21 is such a manner that the said upper end of the valve disc 21

will experience a repulsive force by reason of the effective adjacent north poles N_1 and N_2 of the respective magnetic elements, while the lower south magnetic pole S_1 of the valve disc will experience an attractive force with respect to the north pole N_2 of magnet **35**. This combined repulsive-attractive force combination defines a torque couple which tends to rotate or swing the valving member **20** in a generally counterclockwise direction as seen in FIG. **1**. In that this torque is effectively substantially greater than the said magnetic biasing forces normally retaining member **20** in its FIG. **1** position the disc **21** will be displaced from its "closed" position to its "open" position as diagrammatically illustrated in FIGS. **3** and **4** respectively. This pivotal displacement occurs very rapidly and with a "snap" action. The pivot points in this displacement will lie along the arcuate surface **24** of the upper portion of the disc flange **22** as such surface comes into contact with the adjacent surface of the ferromagnetic washer element **17**, the lower end of disc **21** being free to swing away from the adjacent portions of element **17**. The pin and hole arrangement **31**, **32** will accommodate this swinging motion of the valving member **20** but will not permit the valve disc to radially move, to any significant extent, relative to the axis of the chamber **11**. As long as the magnetic element **35** is held in its said inner position the valving member **20** will thus be held in its open position thereby allowing fluid flow to take place between the inlet and outlet lines **14** and **13**. When it is desired to block or at least impede the flow of fluid between said lines, the magnet **35** is allowed to move back to its said outer position wherein substantially no effective interaction of the magnetic fields exists whereupon the magnetic field of the valve disc **21** in combination with the ferromagnetic annular member **17** restores disc **21** to its normal closed position shown in FIG. **1**; this restoring clockwise movement taking place very quickly and with a snap action.

From the above it will be apparent that as long as the two magnetic fields are not effectively interacting the valve disc will remain in its closed position; however as soon as the two magnetic fields effectively interact the normal holding force on valving member **20** will be overcome thereby causing the valve disc to snap to its open position. Subsequently, when the two magnetic fields are again effectively separated, the valving member will snap back to its normal closed position. This snap action provides a very rapid valve opening and closing operation and is very beneficial to the speed, accuracy and efficiency of the valving function. One model of the instant device has been found to have a rise time of 1 to 2 milliseconds, and to be capable of operating reliably and contaminant free over long periods of use. Further, the above-described valve shifting action is produced by a very short predetermined stroke of the control magnet **35**.

As will be apparent the washer or annular element **17** may constitute the magnetic element while the disc **21** comprises the armature therefor that is made of iron or other magnetic material; the washer element **17** here being magnetized in the same manner as described in connection with FIG. **2** for disc **21**.

Since many changes should be made in the embodiment of the invention as particularly described and shown herein without departing from the scope of the invention, it is intended that this embodiment be considered as exemplary and that the invention not be limited except as warranted by the following claims.

I claim:

1. A valve arrangement: comprising

a main body having a chamber formed therein; said main body being provided with inlet and outlet lines that communicate with said chamber;

a magnetizable member disposed in said chamber;

a magnetized member disposed in said chamber;

one of said members being adapted to be moved between valve-closed and valve-open positions for respectively blocking and permitting fluid flow through said lines; said magnetized member being magnetized so that the effective axis of its magnetic field is disposed in a first direction to thereby cause said one of said members to be normally magnetically biased to a valve-closed position;

said one of said members having a dislike configuration that includes an axially extending peripheral projection that has a rounded outer profile so as to facilitate the pivotal movement of said one of said members in said chamber;

means for sealing said chamber;

magnetic operating means external of said chamber, the axis os the magnetic field of said magnetic operating means being disposed in a second direction; an

means mounting said magnetic operating means for movement towards and away from said members so that the magnetic fields of said magnetized member and said magnetic operating means may move respectively into and out of mutual interaction;

said one of said members being displaced against its said normally biased condition to an open position when said magnetic operating means is moved so that said fields interact in a manner such that opposed portions of said one of said members respectively experience repulsive and attractive forces which produce a torque that pivots said one of said members on the said rounded outer profile thereof to a valve-open position.

2. Apparatus as defined by claim **1** wherein said main body includes a pin that extends into an aperture formed in said one of said members.

3. Apparatus as defined by claim **2** wherein said sealing means includes a cap that supports said pin.

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