United States Patent

[11] 3,626,964

[72] Inventor Harvey G. Van Fossen
Mishawaka, Ind.

[21] Appl. No. 69,299
[22] Filed Sept. 3, 1970
[45] Patented Dec. 14, 1971

[73] Assignee The Wheelabrator Corporation
Mishawaka, Ind.

[54] REGULATING VALVE FOR MAGNETIC MATERIALS

8 Claims, 6 Drawing Figs.

[52] U.S. Cl. 137/81.5, 137/802
[51] Int. Cl. F16k 9/00
[50] Field of Search 137/81.5, 251

[56] References Cited

UNITED STATES PATENTS

3,405,728	10/1968	Dexter	137/251
3,448,751	6/1969	Bosaen	137/251 X
3,548,853	12/1970	McEven	137/81.51

Primary Examiner—Harold W. Weakley
Attorney—McDougall, Hersh & Scott

ABSTRACT: A valve for regulating the flow of materials which are made up of a substantial portion of magnetic particles, the valve being characterized by improved flow rate control means. The valve includes an outer member and an assembly consisting of a permanent magnet and an electrical coil, this assembly providing a core member with a flow through passage being provided by spaces defined between the core member and the interior wall of the outer member. Means are provided for energizing the coil and for varying the input to the coil to vary the influence of the magnet on the particles and thereby regulate the flow of the material through the valve. The spaces defined between the pole pieces and the interior wall vary between minimum and maximum dimensions, and the energization of the electrical coil is controlled whereby the flow rate can be suitably maintained at desired levels and readily changed between different flow rates.

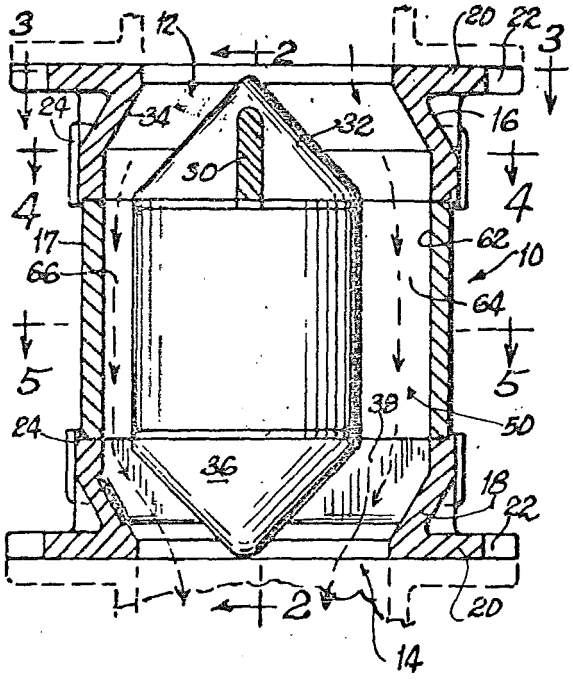


FIG. 1

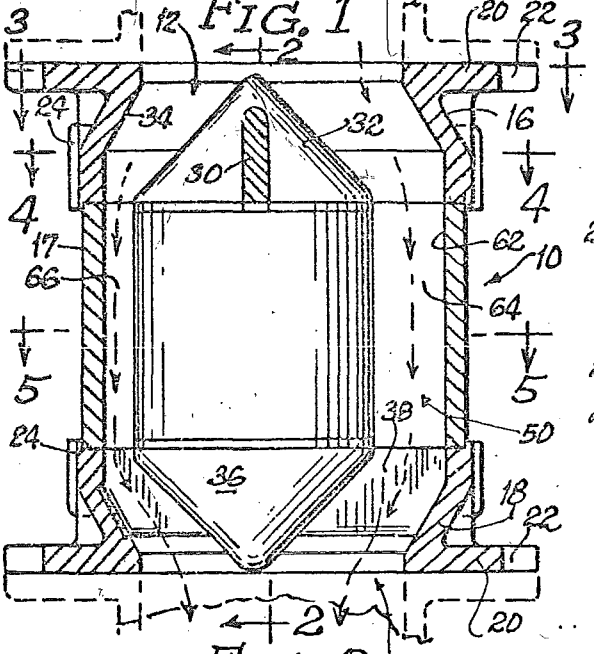


FIG. 2

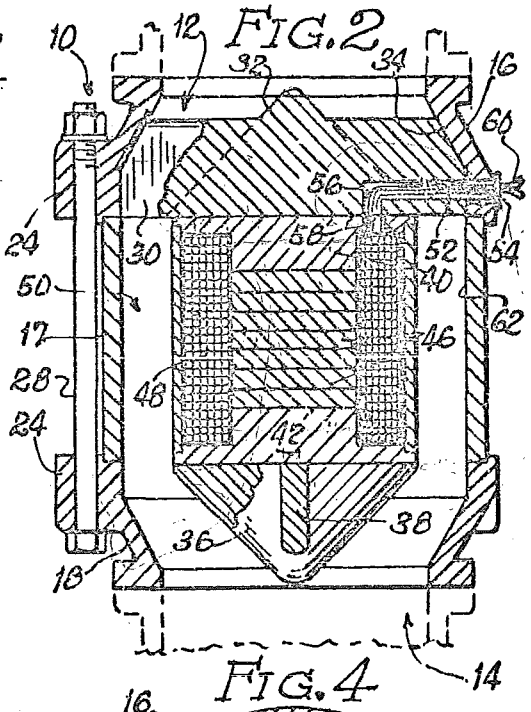


FIG. 3

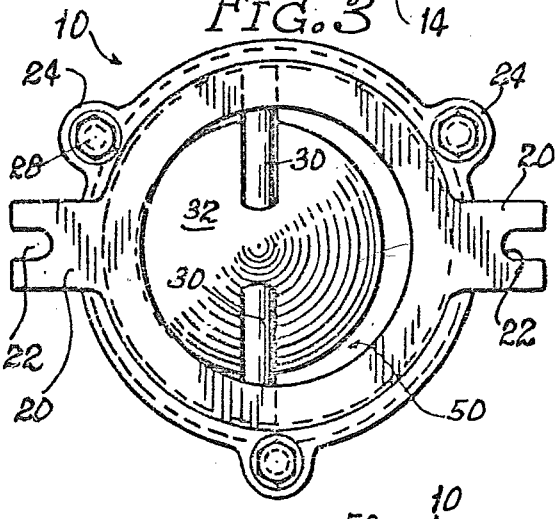


FIG. 4

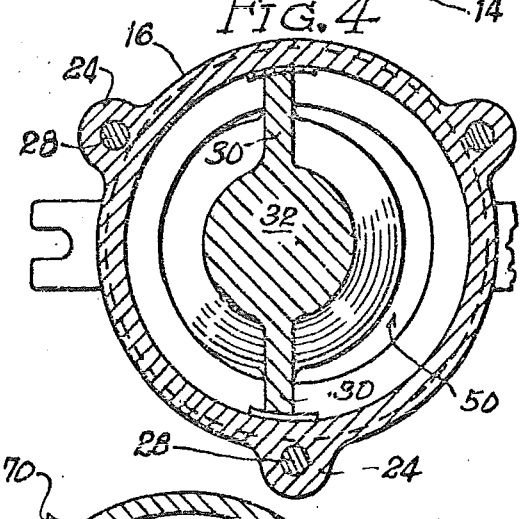


FIG. 5

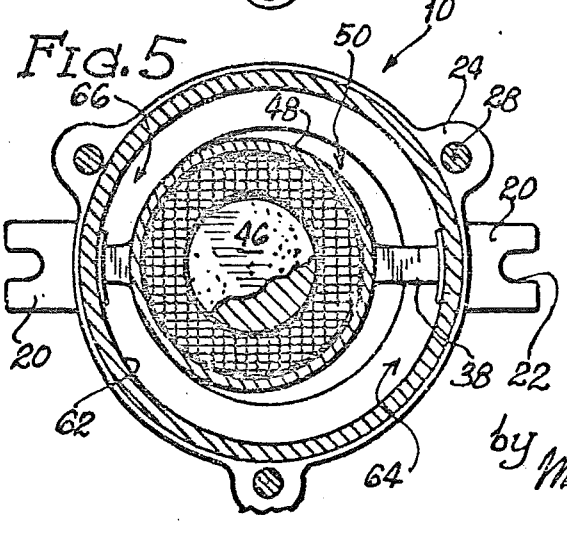
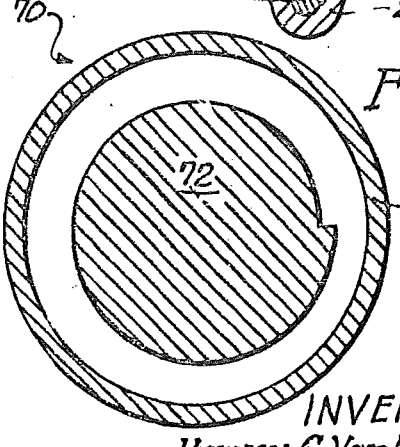


FIG. 6



INVENTOR
Harvey G. VanFossen
by McDougall, Hersh & Scott Attys

REGULATING VALVE FOR MAGNETIC MATERIALS

This invention relates to an improved valve construction. The invention is particularly directed to a valve construction of the type described in Van Fossen U.S. Pat. No. 3,406,704 which is employed for modulating the flow of materials which are composed of a substantial portion of magnetic particles.

There are various applications which require the feeding or other movement of materials in particle form. In certain instances, it is desirable to provide means for regulating the flow of the particles whereby the feeding rate can be controlled. Materials in particle form have characteristics similar to fluids whereby valves can be employed for regulating flow. Problems arise, however, since solid particles have a greater tendency toward clogging or otherwise disrupting valve operations whereby high maintenance and replacement cost result. Such difficulties arise particularly where the particles are abrasive in character.

This invention described in the aforementioned patent discloses means for modulating the flow of particles which have magnetic characteristics. The construction described is ideally suited for use in conjunction with systems which employ abrasives for the cleaning of metal surfaces or the like. Various abrasives, such as shot, are magnetic in character, and it is highly desirable to provide suitable flow regulating means for such materials because of their abrasive characteristics.

The valve described in the aforementioned patent presents some difficulties when starting material flow and during change from one flow rate to another. It has been found desirable to provide a valve of the type described in the patent which is characterized by means for starting material flow at a very low rate while also permitting smooth changes in flow rate. With an arrangement of the specific type defined in the aforementioned patent, it is difficult to start material flow at a very low rate since the energization of the coil will cause material to flow all around the passage provided and, similarly, changes in the voltage applied will result in rather abrupt changes in flow rate rather than providing a smooth transition.

In considering the following description, it will be appreciated that the valves described can readily be employed for other applications, not necessarily involving the handling of abrasive cleaning materials.

It is the general object of this invention to provide an improved valve construction which can be employed for regulating the flow of particles which comprises a substantial portion of magnetic particles.

It is a more particular object of this invention to provide a valve construction of the type described which is characterized by operating means permitting gradual changes in the flow rate of materials moving through the valve whereby the flow rate can be varied between very low initial rates to maximum flow rates on a controlled basis.

These and other objects of this invention will appear hereinafter and for purposes of illustration, but not of limitation, specific embodiments of this invention are shown in the accompanying drawings in which:

FIG. 1 comprises an elevational view, partly in section, of the valve construction of this invention;

FIG. 2 is a vertical sectional view taken about the line 2—2 of FIG. 1;

FIG. 3 is a plan view taken about the line 3—3 of FIG. 1;

FIG. 4 is a horizontal sectional view taken about the line 4—4 of FIG. 1; and

FIG. 5 is a horizontal view taken about the line 5—5 of FIG. 1; and,

FIG. 6 is a horizontal sectional view of an alternative form of the invention.

The valve construction described in the aforementioned patent generally comprises a flow through passage defined between spaced-apart wall portions of the valve. A permanent magnet is associated with the valve adjacent at least one of the walls whereby magnetic particles which pass through the flow through passage are adapted to be attracted by the magnet.

An electrical coil is also associated with the valve. This coil is located in proximity with the magnet whereby energization of the coil will influence the magnetic field produced by the magnet. Means are provided for varying the input to the coil so that corresponding variations in the action of the magnet can be realized. The system may be designed so that the effective magnetic field can vary from a condition which will prevent the passage of the abrasive material to a condition which will provide virtually free flow of the material, or a system varying between minimum and maximum flow rates may be utilized. Reference is made to copending application Ser. No. 737,183 for a description of a suitable operating arrangement.

The structure of this invention is particularly characterized by nonuniform spacing between the valve wall and the assembly comprising the coil magnet and pole pieces. With this physical arrangement, and through the use of means for changing the voltage applied to the coil, it has been found that the flow rate of the materials through the valve can be initiated at a very low level. Thus, the nonuniform spacing will provide an area of weakest magnetic flux density, and material flow will begin in this area in preference to all other areas when voltage of a minimum amount is first applied. As the voltage increases, the flux density in surrounding areas will gradually decrease to levels permitting additional material flow. This has been found to be an ideal system for permitting gradual changes in material flow between a very low flow rate to a maximum flow rate.

This the accompanying drawings, FIGS. 1 through 5 illustrate a valve 10 characterized by the features of this invention. this valve is adapted to be associated with an abrasive cleaning machine whereby abrasive particles can be fed into the inlet end 12 of the valve and out of the outlet end 14. In one contemplated application of the invention, the valves are employed for feeding centrifugal wheels. In such an instance, the valve is mounted in association with the wheel housing, and the centrifugal blades engage abrasive passing through the outlet 14 for throwing of the abrasive onto articles to be cleaned. The valve of this invention is intended to replace valves which have previously been employed in conjunction with such abrasive cleaning machines, and the mounting of the instant valves in association with such machines is essentially the same as in the case of previously used valves.

The valve is formed by means of a pair of outer sections 16 and 18, and an intermediate cylindrical section 17. The sections 16 and 18 include flange members 20 defining openings 22 whereby the respective sections can be mounted in a desired position. Each of the sections 16 and 18 also includes protruding portions 24. These portions each receive bolts 28 utilized for securing the assembly together.

Extending inwardly from the section 16 are a pair of wings 30 which are integrally formed with a conically shaped cap member 32. The ends of these wings 30 are shaped whereby they interfit the inclined interior surface 34 of section 16. A similar conically shaped cap member 36 is provided with wings 38, and this arrangement is located near the outlet end of the section 18.

Located intermediate the cap members 32 and 36 is a magnet and coil assembly. This assembly includes pole pieceS 40 and 42 which can be cemented or otherwise secured to the respective cap members. Permanent magnets in the shape of discs 46 are located in stacked relationship between the pole pieces 40 and 42. An electrical coil preferably in the form of an elongated wire is wound around the magnets and pole pieces to form the cylindrical arrangement 48. An annular passage 50 provides the flow through passage for the construction.

A bore 52 is defined by one of the wing members 30, and an opening 54 in the section 16 communicates with the bore 52. Passage 56 extends from the bore 52 to passage 58 formed in tne pole piece 40. This arrangement provides for the connection of electrical leads 60 to the coil 48. Both leads may pass through the described passages; however, a second passage

could obviously be formed in a similar manner through one of the other wings.

As shown in the drawings, the vertical axis of the assembly comprising the pole pieces 40 and 42, permanent magnets 46 and coil 48 is offset from the center line of the sections forming the valve housing. Accordingly, the spacing between the inner wall 62 of the cylindrical section 17 varies from a maximum dimension at 64 to a minimum dimension at 66.

In the operation of the described construction, material is passed into the inlet 12 and through the passage 50. If the valve is to provide for essentially free flow of the particles, the electrical coil 48 is energized to the extent necessary for offsetting the influence of the permanent magnets 46. With the arrangement, substantially free flow of the particles can be accomplished.

When the flow of particles is to be retarded, the energization is varied by the necessary amount to achieve a reduction in flow rate. Obviously, the flow of particles can be substantially stopped by deenergizing the electrical coil provided permanent magnets of the necessary strength are employed. It will be appreciated that complete stopping of the flow may not be necessary for some applications.

The nonuniform spacing between the housing wall and the assembly including the permanent magnets, coil and pole pieces provides an ideal means for controlling the flow rate of material through the valve. The control is made possible due to the fact that the flux density is weakest in the area of the maximum space dimension 64. As the coil is energized, a level is reached which will initiate flow of material in the limited area of maximum spacing. Accordingly, a very low flow rate of abrasive material can be accomplished in this area. Direct current voltage is preferably employed for energizing the coil, and as this voltage is increased, the flux density in the areas adjacent the areas of maximum dimension will be decreased. Accordingly, gradually increasing portions of the valve will permit the flow of material. Eventually the direct current voltage can be increased to the point where a full open condition of the valve is realized.

The valve operation is also enhanced if the outer sections 16 and 18 and the cap members 32 and 36 are formed of nonmagnetic material. It will be noted that the spacing between these sections and members is nonuniform when measured along any vertical line. It was found that if magnetic material were used for forming these members, then the operation of the magnet and coil assembly would create magnetic influence in these areas. Because of the nonuniform spacing, these influences varied to the point that the overall valve operation was affected. By using nonmagnetic material for these sections and members, these influences were eliminated.

FIG. 6 illustrates a valve construction 70 which includes an assembly 72 which includes the pole pieces, etc., the assembly being positioned within cylindrical section 74. This assembly differs in that it defines a cam-shaped cross section whereby the gap between the assembly and the cylindrical section will vary constantly all around the pole pieces. By providing a gap variation in this manner, essentially the same operating characteristics can be achieved. The maximum and minimum spacing in a design such as this may vary between seven-eighths and three-fourths inches.

The operation of the valve of the instant invention differs in significant respects from the operation of prior valves, for example as described in the aforementioned patent. Thus, the valve described in said patent is characterized by a relatively high minimum or initial flow rate. This occurs since the application of the minimum voltage required to commence flow results in material flow around the entire 360° flow through passage. With the arrangement of the instant invention, the gradually changing spacing between the interior wall of the valve housing and the core assembly provides a means for controlling the degree of material flow. Thus, a gradually increasing area of material flow can be developed until complete material flow is accomplished. This, of course, represents a means for controlling material flow over and above the control which is inherently provided due to the magnitude of attraction of the magnetic particles which is a common feature of the patented valve and the valve of the instant invention.

The valve construction described can be utilized in conjunction with materials which comprise a substantial portion of particles adapted to be attracted by magnetic forces. The invention contemplates the handling of mixtures of magnetic and nonmagnetic materials, particularly where the dominant portion of the materials is magnetic and will influence the flow rate of all the materials.

The valve will function even when the major portion of the material is nonmagnetic and a minor portion is magnetic In such case, it will have a slightly slower response to changes in magnetic field. For example, if a mixture of 40 percent magnetic steel shot and 60 percent sand, by volume, was passing through the valve at full flow rate, the coil could be partially deenergized such that the permanent magnets will attract the magnetic particles in the mixture and restrict the opening in the valve, thus reducing the flow of both magnetic and nonmagnetic material through the valve. When the coil was fully deenergized, still more magnetic particles would be attracted to the permanent magnet with the sand momentarily passing through the valve, but with more oncoming magnetic particles being quickly attracted by the magnet, almost instantaneous blocking of the entire passage within the valve by the magnetic particles will result and thus prevent flow of the nonmagnetic particles through the valve.

As described in the aforementioned patent, there are various applications possible for valve structures of the type disclosed. Thus, the valve of the instant invention can be utilized in association with centrifugal blasting equipment and for other uses. The materials employed for producing a valve of the instant invention may be the same as described in the patent. Specifically, seven permanent magnets having a diameter of 2.38 inches formed of Indox 5 and magnetized to full strength are stacked. The total length of the stack was 2.506 inches with an air gap 64 between the magnets and the housing 18 being 1 1/16 inches and the air gap 66 thirteen-sixteenths of an inch. An electrical coil formed of No. 23 gauge ML. copper wire with a wire coating epoxy capable of withstanding temperatures to 357° F., is associated with the magnets. The leads are 12 inches minimum length and of 20-gauge Teflon type E insulated wire. The coil power rating is 175 watts plus or minus 10 percent with a coil resistance of 45 ohms.

The maximum air gap at 64 should be from 1.1 to 2 times greater than the minimum air gap at 66. In addition to employing an arrangement wherein the axis of the pole, coil and magnet assembly is simple offset relative to the axis of the surrounding housing, other means may be utilized for achieving variations in flux density at a given voltage level. Specifically, the respective axes could be coincident; however, the ID of the housing could be machined offcenter. Alternatively, the pole pieces employed could be located in an offcenter position even though the magnet and coil assembly remained on an axis coincident with the axis of the cylindrical housing.

It will be understood that various changes and modifications may be made in the above-described construction which provide the characteristics of this invention without departing from the spirit thereof particularly as defined in the following claims.

That which is claimed is:

1. In a valve for use in the handling of materials which are in particle form and which comprise a substantial portion of magnetic particles, the valve comprising an interior wall defining a flow through passage, an assembly comprising a permanent magnet and an electrical coil associated with said valve adjacent the interior wall thereof, said magnet being adapted to attract said particles and to thereby impede movement of the particles through the passage, said electrical coil being located adjacent said magnet, means for energizing said coil, and means for varying the input to said coil for thereby varying the influence of said magnet on said particles, the im-

provement wherein said assembly is positioned within said interior wall, and wherein the spacing between said interior wall and the exterior surface of said assembly varies between a minimum dimension and a maximum dimension.

2. A construction in accordance with claim 1 wherein said spacing increases uniformly from said minimum dimension to said maximum dimension.

3. A construction in accordance with claim 2 wherein the flow through passage of said valve is circular in cross section and wherein said assembly is also circular in cross section, the vertical axis of said flow through passage being displaced relative to the vertical axis of said assembly.

4. A construction in accordance with claim 2 wherein said valve comprises a cylindrical housing, the axis of said assembly being positioned coincident with the axis of said housing, and wherein the internal diameter of said housing is produced offcenter relative to said axis.

5. A construction in accordance with claim 1 wherein pole pieces are secured in said assembly, said pole pieces being positioned offcenter relative to the axis of said valve.

6. A construction in accordance with claim 1 wherein said maximum dimension is between about 1.1 and 2 times greater than said minimum dimension.

7. A construction in accordance with claim 1 wherein said assembly defines a cam-shaped cross section.

8. A construction in accordance with claim 5 wherein cap members are secured to the outer surfaces of said pole pieces, wings carried by said cap members, and end sections secured at the opposite ends of said interior wall, said wings securing said cap members to said interior wall, and wherein said cap members and said end sections are formed of nonmagnetic material.

* * * * *