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FLOW REGULATING VALVE FOR MAGNETIC PARTICLES

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ABSTRACT OF THE DISCLOSURE

A valve for regulating the flow of materials which are made up of a substantial portion of magnetic particles. 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.

This invention relates to an improved valve construction. The invention is particularly directed to a valve construction which can be effectively 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 costs result. Such difficulties arise particularly where the particles are abrasive in character.

This invention is particularly concerned with means for modulating the flow of particles which have magnetic characteristics. The construction of this invention is ideally suited for use in conjunction with constructions 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. 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 comprise 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 a design which substantially reduces malfunctioning of the valve and which eliminates the need for frequent repair and replacement.

It is a still further object of this invention to provide a valve design which is particularly suitable for use in conjunction with constructions which employ abrasive materials for use in the cleaning of metal surfaces and the like.

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:

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

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

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

FIGURE 4 is a horizontal sectional view taken about the line 4—4 of FIGURE 1;

FIGURE 5 is a horizontal view taken about the line 5—5 of FIGURE 1;

FIGURE 6 comprises a vertical sectional view of an alternative form of the invention; and,

FIGURE 7 is a horizontal sectional view taken about the line 7—7 of FIGURE 6.

The valve construction of this invention 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 an 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 is preferably 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.

The accompanying drawings 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**. The respective sections include flange members **20** defining openings **22** whereby the respective sections can be mounted in a desired position. Each of the sections also includes flange members **24**. These flange members each define openings **26** whereby fasteners **28** can be utilized for securing the respective sections 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 with 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 the magnet and coil assembly of this invention. 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 is located at the juncture of the cylindrical members 14 and 18 for communication with the bore 52. Passage 56 extends from the bore 52 to passage 58 formed in the pole piece 40. This arrangement provides for the connection of electrical leads 59 to the coil 48. Both leads 59 may pass through the described passages.

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 this 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 de-energizing the electrical coil provided permanent magnets of the necessary strength are employed. It will be appreciated that stopping of the flow may not be necessary for some applications.

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 non-magnetic 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 de-energized 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 non-magnetic material through the valve. When the coil was fully de-energized, 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 non-magnetic particles through the valve.

One contemplated application of the invention comprises the use of the described constructions as abrasive control valves for a machine such as described in United States Patent No. 3,188,776. In such constructions, two or more multiple centrifugal wheels operate in tandem, and in some instances, shot is used in one section of the construction and grit in another. Depending upon the type of material to be cleaned, different amounts of shot and grit are employed for providing optimum cleaning. With the valves of this invention, the abrasive flow for any given section can be automatically regulated depending upon the grade of steel being cleaned. Variations can also easily be made once an operation has begun. The use of these valves is quite important from the standpoint of initial machine design since the machine can be provided with enough wheels and enough horsepower in each section to meet all possible variations. The given sections can then be readily operated at desired speeds for a given job.

In some instances, wide strip is cleaned by applying abrasive from three or more wheels which are located in side-by-side relationship for covering the entire width of the steel. Since such strips may vary in degree of scale thickness or scale toughness at different locations, such as the edges as contrasted to the middle, it is highly desirable to have reliable valve means for applying abrasives at different rates to different areas of the steel surface. The valve means are also ideally suited for situations wherein the operation of a particular line is cut back without being completely stopped. For example, there may be insufficient steel for cleaning over a given period of time; however, a steady flow may be desired and, therefore, temporary operation at half line speed and at half the rate of abrasive flow is undertaken. The valves of this invention readily permit such an arrangement.

The electrical coil is preferably energized from a DC source. In such an instance, modulation of the flow can be efficiently accomplished since a plot of voltage against abrasive flow becomes practically a straight line function.

In one particular form of the invention, seven permanent magnets formed of Indox 5 and magnetized to full strength are stacked. The diameter of the magnets was 2.38 inches, the total length of the stack was 2.506 inches with an air gap 50 between the magnets and the housing 18 of one inch. An electrical coil formed of No. 23 gauge ML copper wire with a wire coating epoxy capable of withstanding temperatures to 357° F. was associated with the magnets. The leads were 12 inches minimum length and of 20-gauge Teflon type E insulated wire. The coil power rating was 175 watts plus or minus 10 percent with a coil resistance of 45 ohms.

The pole piece extensions 40 and 42 serve a very useful purpose in the construction. These extensions add approximately 1¼ inches to each end of the magnets, and they permit the use of a smaller diameter coil for purposes of neutralizing the magnetization of the permanent magnets. The use of a larger coil compressed into the length of the permanent magnets would require a substantially greater voltage for achieving the same results, and excessive heat would be developed in the coils which could cause them to burn out.

The conically shaped cap members 32 and 36 also serve a very useful purpose in the construction. They streamline the abrasive flow through the valve and most important, they can be made of abrasion-resistant, non-magnetic and good heat conducting material. Preferably, the cap members comprise a cast mixture of fine sized silicon carbide and epoxy cement so that they protect the pole piece extensions 40 and 42 from wear, and they dissipate heat away from the electric coils by transferring the heat to the abrasive flowing over the caps.

The construction shown in FIGURES 6 and 7 comprises an alternative form of the invention. This arrangement includes a cylindrical section 70 defining a flow through passage 72. Upper and lower flanges 74 can be utilized for securing the cylinder 70 in the manner previously described.

Pole pieces 76 extend into the flow through passage through openings 78 in the walls of the cylinder 70. The pole pieces are interconnected by means of a bar 80, and this bar comprises a permanent magnet whereby the pole pieces will attract abrasive particles in accordance with the previous description. The cylinder 70 is preferably formed of a non-magnetic stainless steel whereby it will have no direct influence on the magnetic characteristics of the system.

An electromagnetic coil 82 is wrapped around the permanent magnet 80, and the electrical leads 84 provide for energization of the coil. This alternative arrangement is, thus, adapted to operate in a manner similar to the above described arrangement. The coil 82 will influence the permanent magnet characteristics to the extent that the pole pieces 76 can act as valve means for regulating the flow of abrasive particles through the cylinder 70.

This alternative arrangement is particularly useful where hot particles are passing through the valve. Heat build-up around the electromagnetic coil can be avoided when this coil is located outside the passage. Hot steel abrasives are handled, for example, during their manufacture, where it is desired to take hot abrasive after they have passed through a drier and control the flow over airwash separators to remove slag and other debris prior to heat treating. The alternative form of this inven-

tion finds use in such systems as well as in other systems involving a variety of different operations.

A silicon control DC rectifier varying the DC voltage between 0 and 95 volts is preferably employed with constructions of the type described above. This arrangement or any conventional rectifier is utilized in conjunction with an ordinary 110 volt AC line current. With an arrangement of this type, steel shot will flow when the voltage exceeds about 20 volts and will increase to a maximum at a voltage of about 95 volts with the magnetization being sufficiently neutralized at this point so that it no longer retards the flow of magnetic particles.

The following table provides an illustration of typical flow rates in a system of the type described:

Volts DC to coil:	Pounds per minute abrasive flow round steel shot 0.01 to 0.02" dia.
20	0
25	792
35	1515
45	1962
55	2610
65	3129
75	3651
85	4011
95	4077

The valve constructions of this invention are characterized by various advantages when compared with conventional valves employed for similar purposes. The constructions do not utilize moving parts and, therefore, bits of abrasive will not cause binding or malfunctions in the valves. The arrangements are compact whereby they can be readily incorporated in various machines. The size and elimination of moving parts makes the arrangements extremely inexpensive and easy to install.

A more uniform and accurate regulation or proportioning of the abrasive flow is possible with this valve than with conventional abrasive flow valves. Since the abrasive flow can be stopped when the current is shut off, the valve constructions are essentially fail safe. Thus, any accidental loss in line current will shut off abrasive flow.

The valve constructions do not develop magnetic force outside of the valve housing and, therefore, abrasive dust is not attracted to the valve area. It is also to be noted that the abrasives flowing through the valve do not retain any significant residual magnetism. If any small amount of magnetism is picked up, it is lost during impact after the abrasive is thrown by the centrifugal wheel against the work.

It will be appreciated that various changes and modifications may be made in the construction of this invention 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. A valve for use in the handling of materials which are in particle form and which comprise a substantial portion of magnetic particles, said valve comprising an outer member defining a flow-through passage, a permanent magnet associated with said valve adjacent at least one wall thereof, said magnet being adapted to attract said particles and to thereby impede movement of the particles through the passage, an electrical coil, said magnet and said coil comprising an assembly forming a core member disposed within the confines of said outer member with said passage comprising a space defined between said core member and said outer member, 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.

2. A valve in accordance with claim 1 wherein the assembly comprising said core member includes said magnet in an internal portion with said coil surrounding said magnet.

3. A valve in accordance with claim 2 including cap members covering the ends of said core member and wings associated with said cap members extending outwardly toward the interior walls of said outer member, said wings interconnecting said core member and said walls for supporting the core member within the outer member.

4. A valve in accordance with claim 3 including a bore defined in at least one of said wings, an opening in said outer member communicating said bore with the exterior of said valve, and leads from said coil extending through said bore and out of said opening to provide an electrical connection for said coil.

5. A valve in accordance with claim 2 including pole piece extensions located at the opposite ends of said magnet, and wherein said coil extends beyond said magnet and over said extensions.

6. A valve in accordance with claim 2 wherein said magnet is formed of a plurality of separate discs arranged in stacked relationship, and wherein said coil comprises a continuous length of wire wound in a plurality of turns around said stacked discs.

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FIG. 1

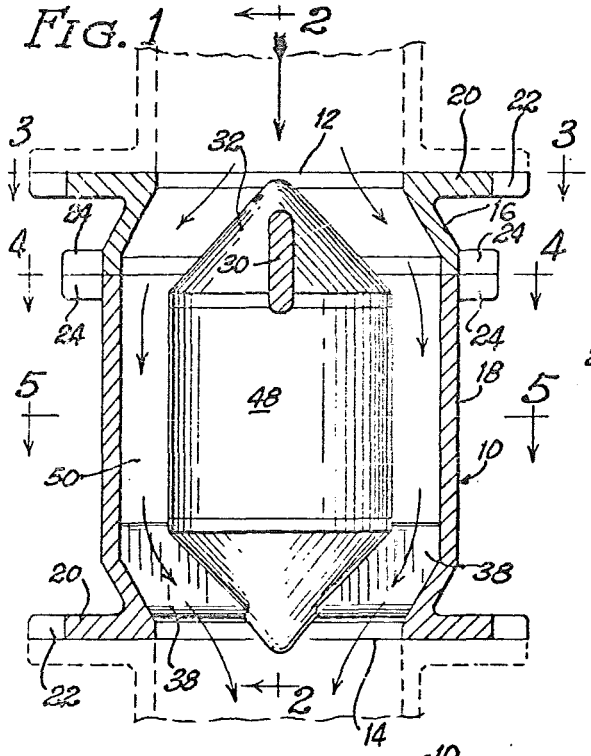
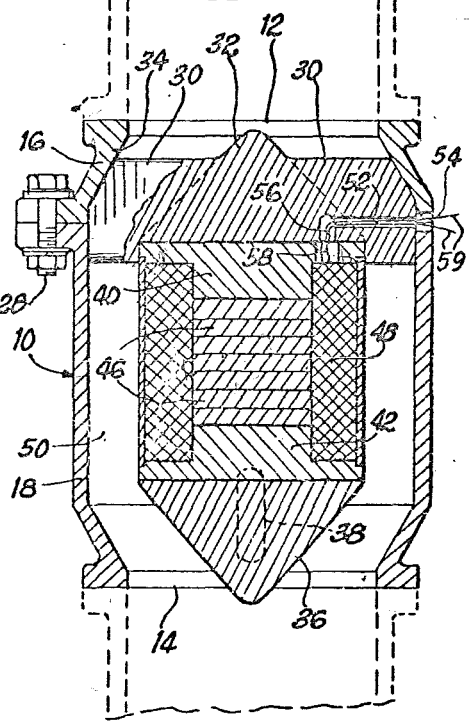


FIG. 2



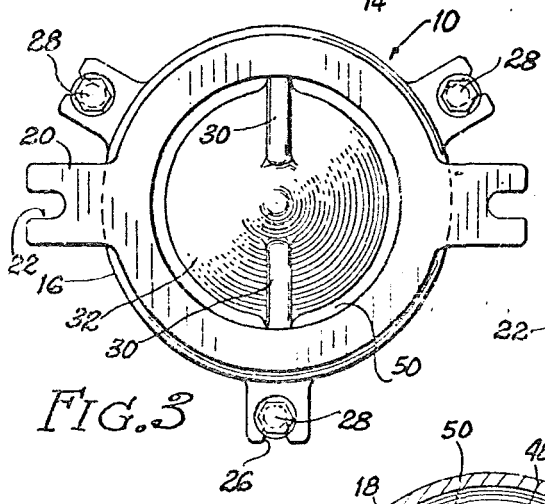
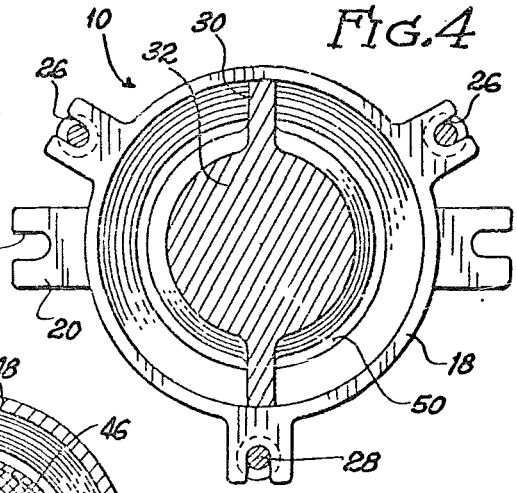


FIG. 3

FIG. 4



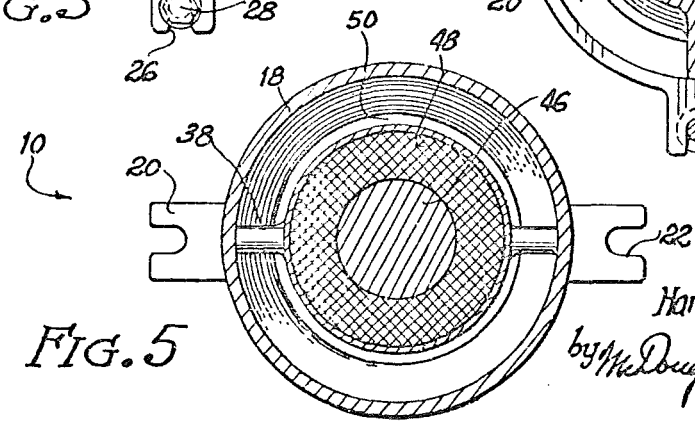


FIG. 5

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FLOW REGULATING VALVE FOR MAGNETIC PARTICLES

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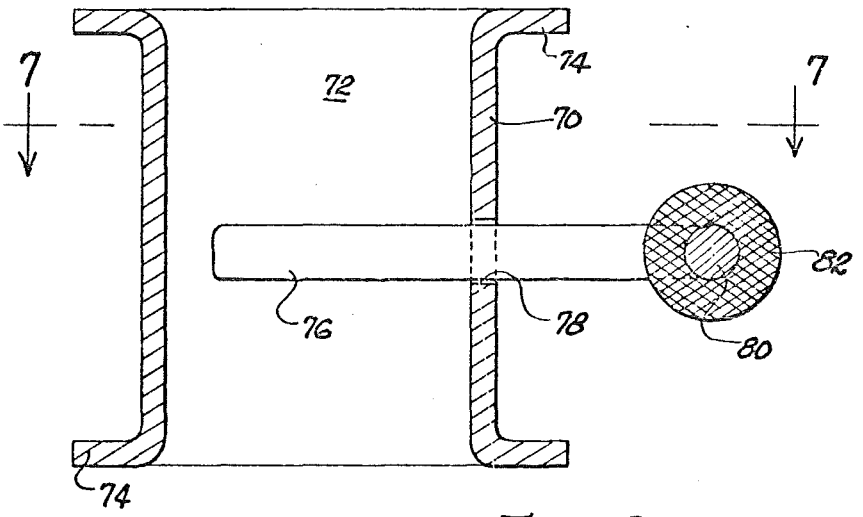

FIG. 6

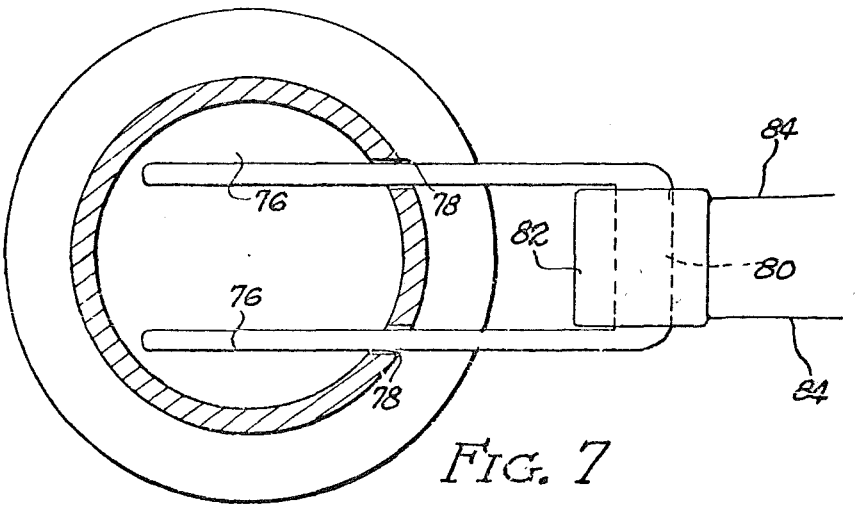

FIG. 7

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