

United States Patent

[11] 3,581,442

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3,101,281 8/1963 Bowen..... 118/7
 3,406,704 10/1968 VanFossen..... 137/251
 3,167,885 2/1965 Gloor..... 51/15

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[54] **CONTROLS FOR ELECTRO-MAGNETIC VALVES**
6 Claims, 7 Drawing Figs.

[52] U.S. Cl.....**51/9, 51/14,**
118/7

[51] Int. Cl..... **B24c 3/14**

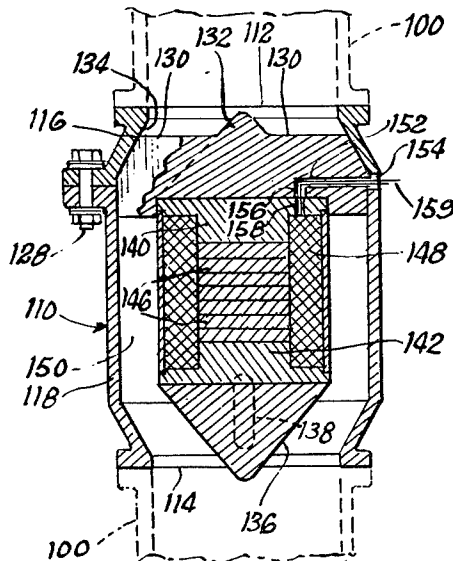
[50] Field of Search..... **51/13, 14,**
15, 9; 118/7, 8, 11

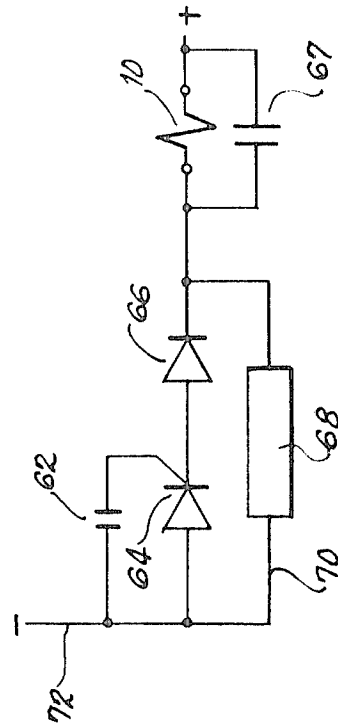
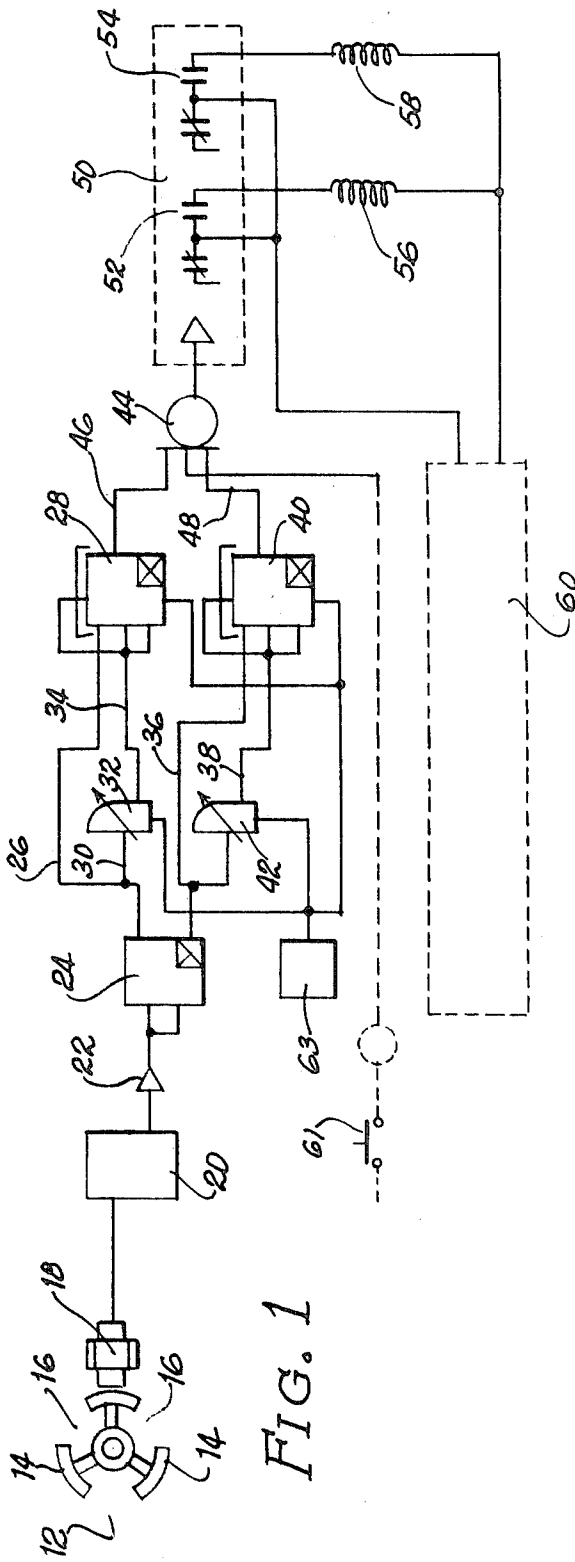
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ABSTRACT: A control system for the passage of abrasive particles into contact with the surfaces of moving objects wherein an electromagnetic valve means is employed for regulating the rate of delivery of the particles. The valve means is operated by an electrical circuit which varies the influence of the magnet on the particles. The variations in influence are achieved in the circuit through the use of a control device which is tied to drive means employed for moving the objects past the mechanisms delivering the abrasive particles. The flow of particles can thus be regulated in accordance with changes in speed of the objects.





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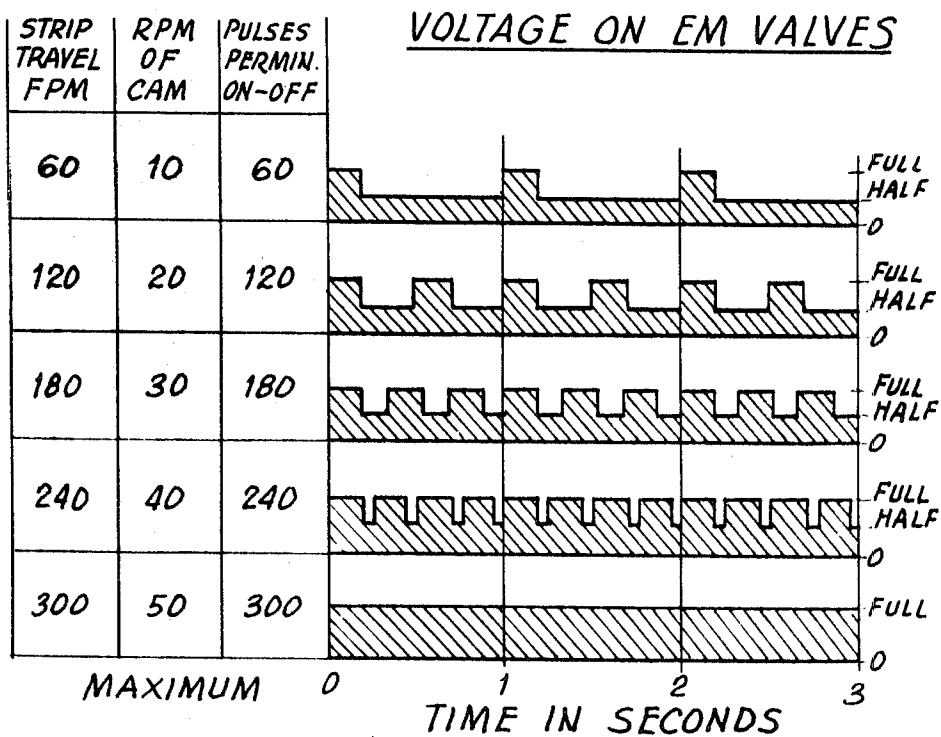


FIG. 3

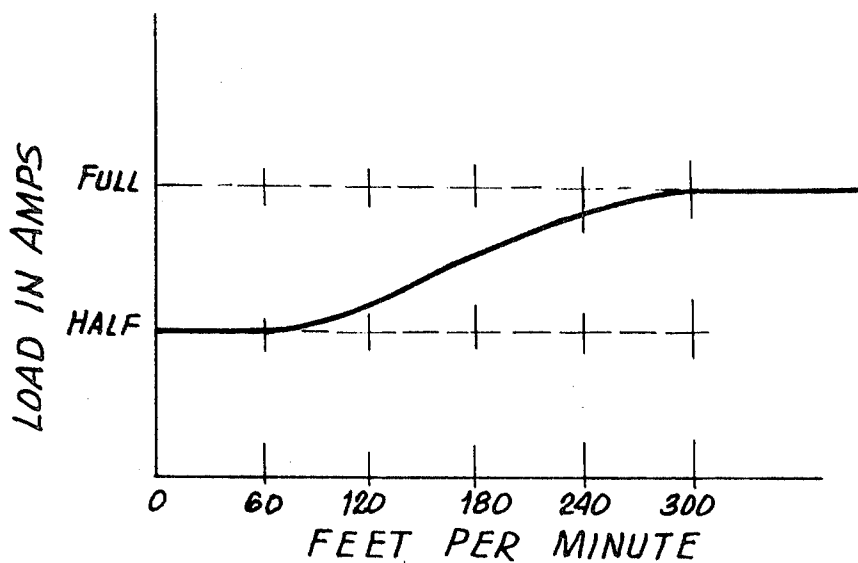


FIG. 4

FIG. 5

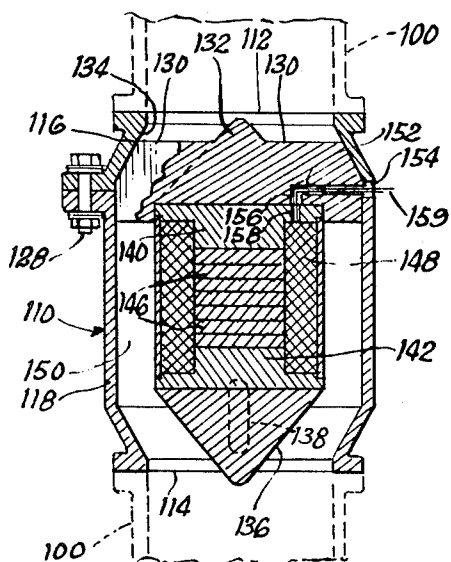


FIG. 7

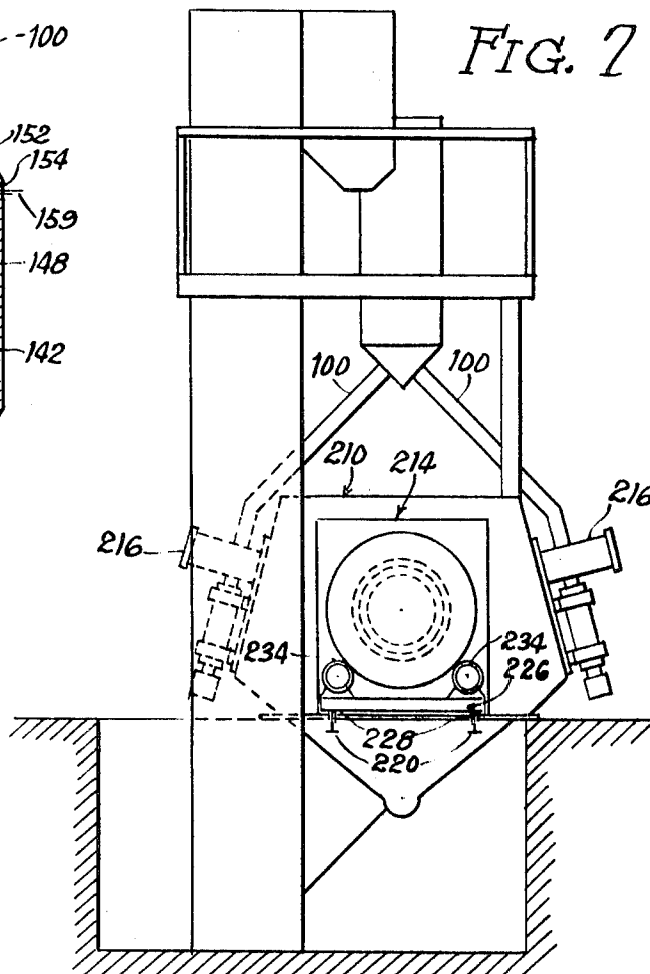
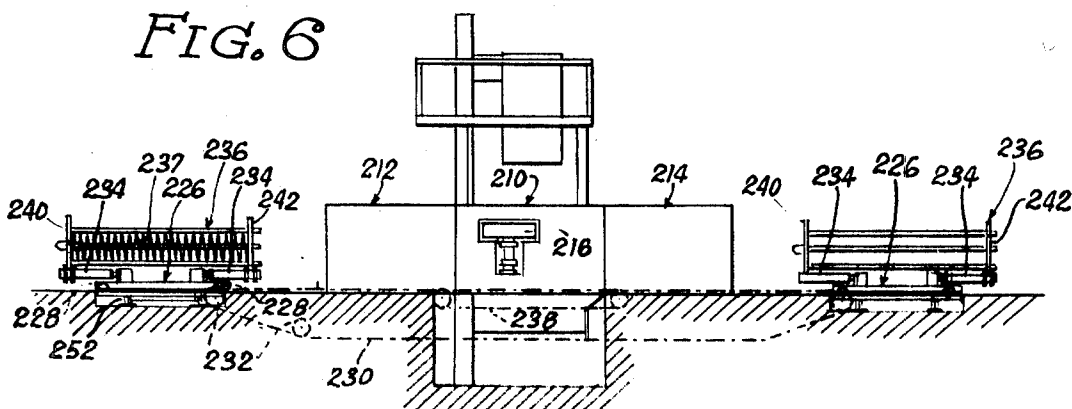


FIG. 6



CONTROLS FOR ELECTRO-MAGNETIC VALVES

This invention relates to control systems for use in the handling of abrasive particles. The invention is specifically concerned with constructions employing centrifugal wheels or other devices which throw abrasive particles onto the surfaces of objects whereby cleaning of the surfaces can be accomplished.

In Van Fossen application Ser. No. 522,318, filed Jan. 21, 1966, now U.S. Pat. No. 3,406,704, dated Oct. 22, 1968 for "Flow Valve For Magnetic Materials," there is described a construction suitable for the handling of abrasive particles. Specifically, the construction comprises an electromagnetic valve adapted to modulate the flow of the particles when at least a portion of the particles are magnetic. This invention relates to a control system suitable for use in conjunction with valves of the type described in this application.

The system of this invention may be applied to the handling of abrasive particles or any other system which involves the handling of similar particles and which involves the movement of objects past devices employed for delivering the particles into contact with surfaces of the objects. The instant invention will, however, be described with reference to the handling of abrasive particles, particularly in conjunction with the use of centrifugal wheels for throwing the particles onto the surfaces of objects to be cleaned through abrasive action.

In the cleaning of objects with abrasives, for example steel strip, it is desirable to apply the abrasives to the strip surfaces in a regular fashion. Thus, the amount of abrasive delivered onto the work should not be so high as to overclean the work which results in unnecessary wear on the abrading machine and in excessive abrasive consumption and in some cases could cause undesirable work hardening of the work surface. On the other hand, the degree of abrasive action cannot be so small that the desired cleaning effect will not be realized.

Irregular application of abrasives is also troublesome where slowdowns occur in the movement of objects being cleaned. For example, in the case of strip abrasive can pile up in certain areas when the strip movement is slow or temporarily halted. This has the effect of masking areas of the strip and prevents effective cleaning in these areas.

It is a general object of the instant invention to provide a system for controlling the abrasive flow in abrasive cleaning systems.

It is a more particular object of this invention to provide a control system which is suitable for use in conjunction with electromagnetic valves of the type disclosed in the aforementioned Van Fossen application.

These and other objects of this invention will appear hereinafter, and for purposes of illustration, but not of limitation, a specific embodiment of the invention is shown in the accompanying drawings wherein:

FIG. 1 is a circuit diagram for a control system;

FIG. 2 is a circuit diagram illustrating the circuitry associated with an electromagnetic valve operated by the control circuit of FIG. 1;

FIG. 3 comprises a chart illustrating performance stages for control systems of the type contemplated by this invention;

FIG. 4 comprises a graphic showing of performance characteristics of a valve controlled by a system of the type contemplated by this invention;

FIG. 5 is a vertical, sectional view of an electromagnetic valve suitable for use in the practice of the invention; and,

FIGS. 6 and 7 are schematic illustrations of an apparatus of the type employing centrifugal wheels for applying abrasives to a moving metal coil.

The system of this invention comprises a method and means for controlling the delivery of particles of abrasive material onto the surfaces of moving objects. The abrasive material must comprise, at least in part, magnetic particles, and the system calls for the delivery of the particles through an electromagnetic valve. The valve may, for example, be included in a line utilized for delivering the particles to centrifugal wheels.

Drive mechanisms employed for moving objects to be cleaned by the abrasive particles are included in the control

system of this invention. For example, if the material to be cleaned comprises an elongated strip, the rollers or other drive means utilized for moving the strip past centrifugal wheels will be employed in the control system.

The control system includes a power source adapted to be selectively connected to the electromagnetic valves. A control circuit includes means for energizing the power source, and the energizing means are dependent for at least a part of their operation on the drive means referred to. In this manner, the volume of abrasive delivered by the electromagnetic valves can be varied in accordance with the speed of the drive means which move the objects to be cleaned.

FIGS. 1 and 2 illustrate the control devices employed for accomplishing the objects of the invention. FIG. 2 illustrates the circuitry which is associated with each electromagnetic valve to be controlled by the circuit of FIG. 1. The coil 10 shown in FIG. 2 is intended to represent the coil of an electromagnetic valve. It will be appreciated, particularly when considering the following description, that a plurality of such electromagnetic valves are to be controlled by the same control circuit. FIG. 2 is representative of only a single electromagnetic valve; however, the circuitry for the other magnetic valves to be controlled by the circuit of FIG. 1 will correspond with the showing of FIG. 2.

FIG. 1 illustrates an operating cam 12 which is adapted to be coupled to the conveyor employed for moving objects past the delivery means for abrasive particles. If, for example, strip is being treated, then the cam 12 may be directly or indirectly connected to a rotating shaft of a drive roller. In any event, the speed of the cam is to be varied in direct proportion to the speed of the conveyor means.

The cam 12 includes solid portions 14 with gaps 16 defined therebetween. A proximity switch sensing head 18 is located adjacent the cam 12, and this sensing head operates, through power supply 20 and amplifier 22, to deliver pulses to an input "AND" logic device 24. The proximity switch arrangement is energized each time the sensing head detects a solid portion 14 and is deenergized each time a gap 16 is detected. Pulses are transmitted for each "ON" and each "OFF" signal generated and, accordingly, six pulses will be transmitted during each revolution of the cam 12.

The logic device 24 includes a direct and an inverted output capability, and for each "ON" signal transmitted to it, the element 24, through its direct output line 26, will deliver a signal to "SEALED AND" logic element 28. The same "ON" signal is transmitted through the line 30 to the delay element 32. This results in a delayed signal being transmitted through the line 34 to the logic element 28.

The inverted output of the element 24 delivers corresponding direct and delayed signals through the lines 36 and 38, respectively, to the logic element 40. A delay element 42 is included in the line 38 for this purpose.

An "OR" logic element 44 receives the output from the elements 28 and 40 through the lines 46 and 48, respectively. The output from the element 44 is delivered to relay output amplifier unit 50.

The relay in the unit 50 operates to close normally open switches 52 and 54 when the relay is energized which in turn, energizes reed relays 56 and 58. The unit 60 represents a source of power for the relays 56 and 58. A manual switch 61 permits the delivery of a continuous signal through the element 44 which is useful, for example, during testing. A resetting means 63 is included in the circuit to set the units 32, 42, 28 and 40 in the "OFF" position to insure proper synchronization at the beginning of an operations.

The relays 56 and 58 are adapted to be associated with banks of coils of the type shown at 10 in FIG. 2. Assuming that the coil of FIG. 2 is associated with a bank operated by the relay 56, the energization of the coil will result through closing of the switch 62 by the relay 56. When this switch is closed, current will be fed to the silicon-controlled rectifier 64 resulting in firing of the rectifier, whereby current will be fed to the coil 10 through diode 66. A capacitor 67 is associated with the

coil 10 to counteract the inductive reactance of the valve coil to insure that the voltage pulses always return to zero thereby giving true pulsing of the abrasive flow.

In the embodiment of the invention shown, a resistor 68 is included in line 70 which extends between the coil 10 and line 72. With this arrangement, the coil 10 will have a constantly applied voltage of a value depending upon the magnitude of resistance in the line. Furthermore, the firing of the rectifier 64 will have the effect of shorting out the resistance 68 whereby full line voltage will be delivered to the coil 10.

FIGS. 3 and 4 illustrate the performance characteristics of electromagnetic valves included in a circuit of the type described. For purposes of this example, it will be assumed that the cam 12 is to turn one revolution for every 6 feed of strip travel. Accordingly, either an "OFF" or "ON" signal will be delivered by the proximity switch for every foot of travel length.

It will also be assumed that the delay elements 32 and 42 are set at one-fifth second. Accordingly, each "ON" pulse transmitted by the element 24 through the line 26 will turn the element 28 on for one-fifth second since the delayed pulse coming through the line 34 will operate to shut off the element 28 one-fifth second after it is turned on. The element 40 will also be turned on for one-fifth second for every "OFF" signal delivered by the element 24, this operation of the element 40, of course, alternating with that of the element 28.

Assuming that a circuit such as shown in FIG. 2 is employed, and further assuming that the resistance 68 permits one-half of full voltage to be constantly applied to the coil 10, then performance characteristics such as shown in FIGS. 3 and 4 are developed. As shown, if the strip is traveling at 60 feet per minute, then the cam 12 will rotate 10 times per minute. This will result in 60 pulses per minute, or one pulse per second, through the operation of the proximity switch. As shown by the upper graphic portion of FIG. 3, the one pulse will result in full voltage on the valves for one-fifth of each second.

As the speed is doubled, trebled and then quadrupled, the duration of full voltage increases accordingly. Thus, two-fifths, three-fifths and four-fifths seconds of full voltage operation are, respectively, realized. When the speed of strip travel has increased to 300 feet per minute, 300 pulses per minute, or five per second are being delivered by the proximity switch. This results in unbroken operation of the coils 56 and 58 whereby the several electromagnetic valves will operate at full voltage without interruption.

As shown in FIG. 4, the electromagnetic valves will deliver abrasives between one-half and full loads as the speed is increased from 60 to 300 feet per minute. Gradual increases in speed will, of course, result in gradual increases in abrasive flow throughout this range. It will be appreciated, however, that the particular example illustrated cannot be considered as limiting the invention since different applications of the system will require variations in setting of the various devices. Furthermore, some operations may be more readily carried out by eliminating the use of a constant voltage irrespective of the line speed or by using an amount of constant voltage other than 50 percent of full voltage.

By proportioning the abrasive flow rates in the manner described, several advantages are realized. Abrasive buildup on the strip can be avoided or minimized, for example, where the strip movement is temporarily halted or slowed down. Furthermore, there is less abrasive breakdown when the flow rate is reduced at lower line speeds. In addition, the use of lower abrasive flow rates at intervals in the operation decreases wear and tear on the equipment and reduced maintenance.

The use of a constant voltage, for example 50 percent of full voltage, in the range of lower line speeds is desirable since it has been found that masking problems are minimal with the lower flow rate. Furthermore, the use of full flow rate in the high-speed range prevents masking problems throughout the range. Thus, for many applications, proportioning of the flow

rates is only necessary in the intermediate speed range where masking problems can be critical.

FIG. 5 illustrates an electromagnetic valve of 3,406,704, type shown in the aforementioned U.S. Pat. No. 3,406,704. The valve is mounted between conduit sections 100 used for delivering abrasive to a centrifugal wheel. Abrasive particles are fed into the inlet end 112 of the valve and out through the outlet end 114. The valve includes outer wall sections 116 and 118 with one or more fasteners 128 being used to hold these sections together.

Extending inwardly from the section 116 are a pair of wings 130 formed integrally with conically shaped cap members 132. The ends of the wings 130 are shaped whereby they interfit with the inclined interior surface 134 of the section 116. A similar conically shaped cap member 136 is provided with wings 138, and this arrangement is located near the outlet end of the section 118.

A magnet and coil assembly including pole pieces 140 and 142 is located intermediate the cap members 132 and 136. Permanent magnets in the shape of discs 146 are located in stacked relationship between the pole pieces. An electrical coil is wound around the magnets and pole pieces to form the cylindrical arrangement 148. An annular passage 150 provides space for particle movement.

A bore 152 is defined by one of the wing members 130, and an opening 154 is located at the juncture of the cylindrical members 116 and 118 for communication with the bore 152. Passage 156 extends from the bore 152 to passage 158 formed in the pole piece 140. This arrangement provides for the connection of electrical leads 159 to the coil 148. Both leads may pass through the described passage.

In the operation of the described construction, material is passed into the inlet 112 and through the passage 150. If the valve is to provide for essentially free flow of the particles, the electrical coil 148 is energized to the extent necessary for offsetting the influence of the permanent magnets 146. 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 deenergizing 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 electromagnetic valves may be associated with feed conduits 100 of the type provided in the apparatus disclosed in Gloor U.S. Pat. No. 3,167,885, issued on Feb. 2, 1965. As shown in FIG. 6, this construction includes centrifugal throwing wheels 216 associated with a housing 210 having plenum chambers 212 and 214. A coil 237 to be surface treated is mounted on a frame 236 which carries rings 240 and 242 for supporting the frame on longitudinally extending rollers 234. The rollers 234 are carried on a car 226 which is supported by means of wheels 228 on tracks 220.

As described in the Gloor patent, an endless drive chain 230 operable over guide rollers 232 is provided for moving the cars 226 through the construction. The cam 12 disclosed herein may be directly or indirectly connected to a shaft of one of these guide rollers whereby the speed of the cam will vary in direct proportion to the speed of the means used for conveying the coil past the centrifugal wheels.

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.

I claim:

1. In a construction for the delivery of particles of material onto the surfaces of moving objects, said particles comprising at least in part magnetic materials, said construction including a drive means for moving said objects past means used for delivering the particles onto the surfaces of the objects, and

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electromagnetic valve means for feeding the particles to the delivery means, said valve means being of the type defining continuously open flow-through passages and having an electromagnetic coil adjacent the passages for controlling particle flow depending on the power applied to the valve means, the improvement comprising a power source, control means for selectively connecting said valve means to the power source with the magnitude of particle flow through the valve means being determined by the power applied, and connecting means for connecting the drive means to the control means, said connecting means operating the control means and thereby determining the operation of the valve means, said connecting means including means for operating the control means at spaced intervals whereby the control means applies power intermittently to said valve means, and means associated with the connecting means for initiating the intermittent application of power, the operation of the connecting means being thereby made dependent upon the speed of said drive means.

2. A construction in accordance with claim 1 wherein said particles comprise abrasive particles for cleaning said objects, and wherein said means for delivering particles onto the surfaces of said objects comprise a plurality of centrifugal throwing wheels, and wherein one of said valve means is associated with each wheel, said control means operating to simultaneously apply power to each of said valve means.

3. A construction in accordance with claim 1 wherein said

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connecting means includes a sensing head disposed adjacent rotating means connected to a drive shaft for said drive means, and wherein said sensing means delivers electrical pulses to said control means with the frequency of said pulses depending upon the speed of said drive means.

4. A construction according to claim 3 wherein said control means includes time delay means set to deliver an electrical output for a fixed time period, each of said pulses operating said time delay means to provide periodic electrical outputs, said electromagnetic valve means being controlled by said electrical outputs.

5. A construction in accordance with claim 4 wherein said valve means is connected to a source of electrical output delivering constant power to the valve means so that the valve means will operate at least in a partially open condition at all speeds of the drive means, and wherein said electrical outputs from the control means operate to shift the valve means to a more fully open condition.

6. A construction in accordance with claim 5 wherein the control means is set to deliver a minimum number of electrical outputs to the valve means at a low-speed range, is set to deliver a variable number of electrical outputs to the valve means in an intermediate speed range, and is set to deliver a sufficient number of electrical outputs to the valve means in a high-speed range to provide for a full open condition of the valve means in the high-speed range.

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