PARTICLE DISPENSER FOR ACCUMULATING FOR SUBSEQUENT RELEASE A CONTROLLED QUANTITY OF FINITE MAGNETIC PARTICLES


Filed: Mar. 15, 1973


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ABSTRACT

A particle dispenser accumulates a controlled quantity of finite magnetic particles which then are released into the environment under a force sufficiently low to allow the released particles to gently float onto a work surface by first collecting the desired quantity and mixture of the particles in a zone near the release aperture of the dispenser and then supplying the proper propulsion force.

20 Claims, 16 Drawing Figures
PARTICLE DISPENSER FOR ACCUMULATING FOR SUBSEQUENT RELEASE A CONTROLLED QUANTITY OF FINE MAGNETIC PARTICLES

BACKGROUND OF THE INVENTION

The present invention is related generally to particle dispensers for releasing finite particles into the environment and more particularly to an apparatus for initially accumulating, for subsequent release, a finite mixture of dry powdered iron onto a magnetized work area for the inspection of cracks in ferrous material, a process commonly known as magnetic particle inspection.

Magnetic particle inspection generally consists of magnetizing the material being tested with various types of suitable well-known equipment and applying a very fine mixture of dry powdered iron to the work area. The magnetic particles are not ordinary iron filings but are made of carefully selected magnetic materials of proper size, shape, magnetic permeability and retentivity. The powders are generally available in several colors to give good color contrast against the color of the work surface being inspected. The powders are normally made up of a predetermined mixture of approximately five different particle sizes ranging from 100 to 325 based on the U.S. standard sieve method of sizing.

The particles used in dry powder form generally depend upon air to carry them to the surface of the work area being inspected. The particles should float to the inspected surface as gently as possible and not be forcibly blown there against. As the powder floats to the magnetized surface, the particles are free to be influenced by the magnetic leakage fields at a defect and accumulate at this point to provide a highly visible indication of the actual extent of the defect.

Excessive or forcibly applied particles are not equally free to be attracted by the leakage field and can actually obscure defects simply by covering them with an excessive amount of particles or simply bouncing out of the influence of the magnetic field due to the excessive force with which they are released. By the same token, an insufficient quantity of particles applied to the same surface can become as unreliable in that the lack of particles will fail to locate all defects in the area being inspected.

In the past, various methods for applying magnetic particles in the proper controlled quantity and in an exemplary mixture have been attempted. The method most frequently utilized is the use of a simple rubber bulb having a perforated shaker cap for releasing the particles into the work area in a manner similar to the action resulting from the impression of a syringe to force fluid out of the neck opening. The rubber shaker method is unreliable in that particles are either painstakingly shaken or sprinkled on the face-up horizontal work surface, or if the bulb is squeezed an excessive quantity of particles are delivered to the work surface, often with too much force. Further, the shaker method is not practical for magnetic particle inspection of vertical work surfaces and is virtually incapable of applying particles to an overhead horizontal work surface. These conditions are quite prevalent in the inspection of pressure vessels, tanks, shipyards, steel fabricating shops and similar inspection work. The difficulty of applying powdered particles to the work surface presents a very serious problem in attempting to establish reliability of the product.

Another recent attempt to design an apparatus for releasing magnetizable powder particles onto a magnetized work surface is based on the paint sprayer principle of picking up and blowing powdered particles by the Venturi/suction principle. A major drawback of this design is that the material weight permits only the finer and lighter particles to be picked up and released through the nozzle. A further recent attempt utilizes air pressure to simply blow powdered particles from a container through a nozzle. Each of these methods have been shown to be unreliable as the delivery of particles cannot be controlled to release an exemplary mixture of varying finite particles onto the work surface.

The present invention seeks to overcome the difficulties of these earlier methods by collecting or accumulating controlled quantity of mixed finite particles. Low pressure air flow is then used to release the collected particles through a suitable discharge orifice and into the environment where they are free to be attracted by the magnetic flux fields of the work surface and float to the leakage points.

SUMMARY OF THE INVENTION

The particle dispenser of the present invention includes an accumulating means located in the proximity of the release or discharge orifice. This permits the collection of a controlled quantity of particles in the vicinity of the aperture prior to release. By releasing the controlled quantity of particles under a minimum force the particles are permitted to flow through the aperture and float to the work surface.

In the case where magnetic particles are utilized, the accumulating means is a magnet having a predetermined magnetic force field for accumulating a controlled quantity of finite particles in a collecting zone in the vicinity of the aperture. An air flow at low pressure is then utilized to release the particles from the magnetic field of the magnet and propel same through the aperture, allowing them to float to a magnetized work surface. A supply means containing a large quantity of the mixture of finite particles may be placed in communication with the accumulating means so that the collection zone may be easily refilled prior to each use. The capacity of the supply means may be varied thus permitting adaptability of the dispenser to various inspection applications.

It is, therefore, an object of the present invention to provide a means for supplying a predetermined mixture of powdered material to a work surface in finite and controlled quantities under low pressure, permitting the particles to float to the work surface in a manner suitable for powder inspection techniques. Other objects and features will be readily apparent from the attached drawings and description.

While a detailed description of exemplary embodiments of the particle dispenser is contained in the drawings and following description, it is to be understood that any modifications may be made in structural details here shown and described, within the scope of the appended claims without departing or exceeding from the spirit and scope of the invention.

DESCRIPTION OF THE DRAWINGS

FIG. 1 is an exploded view of the components of one embodiment of the particle dispenser.
FIG. 2 is a section view showing the assembled components of the first embodiment.

FIG. 3 shows the manner in which the collection means receives a controlled quantity of the finite particles.

FIG. 4 is a section view taken along lines 4—4 of FIG. 2 and corresponding generally to the view shown in FIG. 3. FIG. 4 showing release of the particles into the environment.

FIG. 5 illustrates one position of the collection means for collecting a minimum quantity of finite particles in the vicinity of the discharge orifice.

FIG. 6 shows a second position of the collection means for collecting a maximum quantity of finite particles in the vicinity of the discharge orifice.

FIG. 7 illustrates a typical magnetic flux field about a cylindrical magnet.

FIG. 8 is a second embodiment of the invention.

FIG. 8a illustrates a variation of a detail of the embodiment shown in FIG. 8.

FIG. 9 illustrates an alternative embodiment of the magnetic particle dispensing means of the present invention as contained in the embodiment of FIG. 8, with the accumulating means shown in section.

FIG. 10 is an enlarged elevational view of the dispensing means of FIG. 9.

FIG. 11 is a fragmentary view shown in section, taken along the lines 11—11 of FIG. 9 showing in detail the collection zone of the dispensing means of FIG. 9.

FIG. 12 is an exemplary view of a modification of the accumulating and dispensing means of FIG. 1.

FIG. 13 is a sectional view taken along lines 13—13 of FIG. 12.

FIG. 14 is another modification of the accumulating and dispensing means of FIG. 1.

FIG. 15 is a sectional view taken along lines 15—15 of FIG. 14.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

In FIGS. 1—4, the inventive concept has been applied to a hand dispensing apparatus, wherein the numeral 10 denotes, by way of example, a typical, open-ended, plastic squeeze bottle, or the like, adapted to contain a quantity of mixed, finite magnetic particles 12.

The numeral 11 denotes generally a dispenser head for use with an open-ended squeeze-type container, 10, for providing, in conjunction therewith, a dispenser assembly adapted to release a controlled quantity of finite, magnetic particles into the environment, incident to the expulsion of air from the container when the side walls thereof are squeezed, as in FIG. 4.

The dispenser head 11 includes an end member 13 having an aperture or discharge orifice 26 therethrough, and depending side walls 16 which are internally threaded as at 18 for engagement with the external threads 20 of container 10.

Magnetic particle accumulating means denoted generally by the numeral 30 are located interiorly of head 11 adjacent the discharge orifice 26. In the preferred embodiment of the invention the magnetic particle accumulating means comprises an elongate, substantially cylindrical non-magnetic member or housing 44 having an elongate, substantially cylindrical permanent magnet 46 completely housed therein and disposed in eccentric relationship with respect to longitudinal axis of the non-magnetic member 44.

Accumulating means 30 is suitably associated with head 11 for rotation about its longitudinal axis for enabling an operator to selectively position magnet 46 in any one of a plurality of positions viz, from closely adjacent, to remote from the discharge orifice 26.

Uniformly satisfactory results have been obtained in those instances in which the opposite ends of the non-magnetic member 46 have been rotatably journalled within axially aligned openings 32 provided in the side walls of the head or cap 11.

With particular reference to FIGS. 1 and 2, it will be noted that end member 13 may be provided with an internally threaded opening 40, for the reception of a conical-ended retaining pin 36 and an externally-threaded set screw 38. The conical end of retaining pin 36 is adapted to be received within the circumferential groove or channel 34 of member 44. Suitable means, such as, by way of example, a slot 42 is provided in one or the other of the opposite ends of member 44 for the reception of the bit of a screw driver, or other means, to enable an operator to rotate member 44, and its associated magnet relative to the dispenser head. The particle accumulating means may be securely though releaseably locked in any desired position by tightening set screw 38 against the upper end of retaining pin 36.

It will be noted that the retaining pin also precludes accidental or unintentional endwise axial movement of the particle accumulating means 30 relative to the dispenser head.

In the preferred embodiment of the invention a plate 22, having discharge apertures 28 therethrough, is disposed within the head between the accumulating means 30 and discharge orifice 26. As clearly illustrated in FIGS. 2—4, plate 22 spans the interior of the side walls of the dispenser head being secured in place by any suitable means not relevant to the subject invention.

A gasket 14 of Neoprene, or the like, may be interposed between the free outer edge 15 of the open end of container 10 and the adjacent surface 17 of an offset interiorly of the side walls of the dispenser head, for thereby providing a fluid, or particle-tight connection between container 10 and the dispensing head 11.

During those periods of time when the container is in an upright position the magnetic particles 12 will be located entirely within container 10, at a location remote from the particle accumulating means, as in FIG. 2.

When it is desired to initially activate, and/or thereafter utilize the device of FIGS. 1—4, the container is turned or rotated 180° to the position illustrated in FIG. 3 for gravitationally displacing magnetic particles 12 into the dispenser head. Thereafter, the container is again权利到 the position of FIGS. 2 and 4, at which time a predetermined quantity of magnetic particles 12 will adhere to the outer surface of the non-magnetic member 44, it being understood that those particles which are not so accumulated will fall, by gravity, into container 10.

The application of a squeezing force to the side walls of container 10 will cause the air housed within said container to be expelled outwardly, as indicated by the headed arrows, of FIG. 4, past the particle accumulating means whereby, most if not all, of the magnetic particles accumulated on the non-magnetic member will be discharged through openings 28 of plate 30 thence through discharge orifice 26 whereby to provide a gen-
tle, uniform dispersion of the magnetic particles as indicated by the letter C of FIG. 4.

From the foregoing, it will be noted that by utilizing a magnet 46 having a flux field sufficient to accumulate and retain particles in a "collection zone" 50, said particles will be released or expelled through apertures 28 and 26 in response to a gentle squeeze on the side walls of container 10 to thereby release the particles into the environment whereby they will literally float to the work surface (not shown) and collect about magnetic flux leakage areas in the work surface.

The device of FIGS. 1-4 may be utilized to apply magnetic particles to a magnetizable surface to be inspected, whether said surface be vertical, inclined, irregular, or horizontal, either above or below the location of the dispenser head. When using the device for applying magnetic particles to a surface disposed beneath the dispenser the container 10 is inclined downwardly toward the surface, rather than being disposed at right angles therewith, as in FIG. 3, in order that the air dispelled from the container will be free to act upon the magnetic particles on the accumulating means.

By shielding magnet 46 in a non-ferrous member case or housing 44 the effective force field of the magnet is substantially reduced. As shown in FIG. 7, the magnetic flux is strongest in the area closest to the magnet. Thus, by shielding the magnet, the magnetic force is buffered by the non-magnetic member 44 and the magnetic particles 12 will be attracted by the weaker flux lines of the magnet. This construction permits utilization of a magnet having a strong force structure for retention of magnetic properties over a substantial period of time, while allowing for release of the particles with little force.

By mounting magnet 46 eccentrically with respect to the longitudinal axis of the non-magnetic member, shield, or case 44, it is possible to selectively vary the controlled quantity of particles which will be accumulated in the collecting zone 50, note FIGS. 5 and 6.

When the magnet is in the position as shown in FIG. 5 a lesser quantity of particles will be collected or accumulated since there is a minimum of space between that surface of the non-magnetic member 44 closest to the magnet 46 and the adjacent face of plate 22. However, when member 44 has been rotated as shown in FIG. 6, that surface of the non-magnetic member which is closest to the magnet is remote from plate 22 and a greater quantity of particles 12 will be collected or accumulated unaffected by the crowding effect of plate 22, as in FIG. 5.

A second embodiment of the invention is illustrated in FIGS. 8-11. The basic differences between the embodiment of FIGS. 1-6 and FIGS. 8-11 are the inclusion of means for housing a greater quantity of particles 12, and the utilization of modified particle accumulating and dispensing means 66.

An air tight container 54 having a combination filler cap and pressure relief valve 56 is suitably mounted on wheels 58 and provided with a handle structure 60 to provide maneuverability.

The particulate accumulating and dispensing means 66 includes a non-magnetic member 70 having a slot 72 therein which defines a fill zone into which magnetic particles 12 gravitate. A non-magnetic tube 74 extends across slot 72 with one end extending through and projecting from face 76 of leg 78 of member 66, and with its other end 80 partially extending into an elongate chamber 82 in leg 84 of said member. Tube 74 is secured in place by means of a set screw 75 or the like. The intake or inlet end of chamber 82 is defined by a conical throat 86, and as clearly illustrated in FIGS. 10 and 11, the inside diameter of chamber 82 is greater than the outside diameter of tube 74 by a dimension in the neighborhood of 0.125 inch. The discharge or outlet end of the chamber is provided with a coupling tube 88 to which one end of a delivery hose 90 is connected.

Two or more magnetic particle accumulating means 130 are disposed adjacent chamber 82 in leg 84, wherein each of means 130 includes an elongate non-magnetic member 144 having an elongate magnet 146 housed eccentrically therein, as in FIG. 1. Each member 144 is rotatably mounted within an elongate socket in leg 84 wherein the depth of each socket is such that the end of said member in which slot 142 is located projects from face 143 of leg 84 in order to provide ease of access to said slot for purposes of adjusting the relationship of magnets 146 relative to the outer surface of chamber 82.

Air under pressure from 2-5 p.s.i. is introduced to tube 74 via conduit 92, pressure regulator 94 and valve member 96.

The magnetic field adjacent the opposite ends of magnets 146 is such as to normally preclude the introduction of particulate magnetic particles 12 via throat 86 from slot 72 into the intake end of chamber 82 during those periods of time when air is flowing through tube 74, through that portion of chamber 82 between the end of said tube and coupling 88 and through hose 90. However, whenever the flow of air through hose 90 is interrupted, such as would occur if discharge valve 98 was closed or if the square open end of hose 90 was closed by the finger or thumb of an operator, then and in that event the air pressure developed within the closed, air tight chamber 54 will cause a quantity or predetermined charge of particulate magnetic particles 12 to enter chamber 82 via throat 86 where they will be held or accumulated within chamber 82 by the field of magnets 146.

When the flow of air through hose is resumed the aforesaid charge of particulate magnetic particles within chamber 82 are expelled therefrom to pass through and out of hose 90 onto a surface undergoing magnetic inspection. Once the charge has thus been expelled only air will continue to flow through hose 90, and the only way another charge of particulate magnetic particles can be accumulated in chamber 82 for discharge through the hose is for the flow of air through hose 90 to be momentarily interrupted. The continuous flow of air through hose 90 is desirable to enable an operator to gently blow away any excess particles on the work surface being inspected, thus retaining only those particles attracted by or at the magnetic flux leakage points.

Whereas container 54 is shown as a wheeled carriage for supplying a large quantity of magnetic particles it should be understood that many variations of this container are possible, making the present invention applicable to a wide range of applications. For example, a smaller, portable unit having shoulder straps for mounting the container on the back of the operator would be an alternative to the wheeled carriage. It should further be understood that the number of accumulating means utilized in the dispensing unit 66 vary
only with the desired quantity of particles necessary to perform a particular task.

An exemplary, but less desired modification of the inventive concept is illustrated in FIGS. 12 and 13 utilizing an unshielded magnet 47. A dispenser cap 100 is designed to fit container 10 of the embodiment shown in FIGS. 1 through 6, in a manner similar to cap 16. By providing the upper surface 102 of cap 100 with orifices 104 off-set from center it is possible to vary the amount of "collected" particles discharged or blown from the accumulating magnet 47 by rotating the magnet relative to the orifices of the screen plate. This can be achieved by mounting the magnet 47 on shaft 106 which is rotatably secured to the cap 100.

An alternative to the aforesaid modification is illustrated in FIGS. 14 and 15. The magnet 49 is in this case ring-shaped, forming a collecting zone 50 in the center. The apertures 110 are centered in surface 112 of cap 114 over the inner diameter of ring magnet 49.

It should further be understood that any suitable means for accumulating the particles in the collecting zone near the release aperture would provide a satisfactory embodiment of the invention. The orifices 104 as shown in FIGS. 12 and 13, as well as those in the other embodiments of the invention, serve only as examples to indicate means by which the quantity and direction of the released particles may be controlled. While magnets shielded or unshielded, provide suitable accumulating means for devices wherein a ferrous particulate matter is to be dispensed, it should further be understood that other accumulating means would likewise be suitable for both ferrous and non-ferrous powdered particles.

The preferred embodiments of the invention have been illustrated in FIGS. 1-11 wherein the magnets of the particle accumulating means are encapsulated, as it were, for substantially modifying, masking or reducing the intensity of the magnetic forces to which the magnetic particles are subjected by the particle accumulating means.

The present invention contemplates and is directed not only to a complete device such as illustrated in FIGS. 2-4 and 8, but also to the dispenser and accumulating head or means, per se, of cap 11 and member 66, which when associated with a suitable source of magnetic particles and a source of air constitutes an operable assembly.

What is claimed is:

1. A particle dispenser for releasing a controlled quantity of finite, ferrous particles into the environment under low pressure to allow the particles to float onto a work surface, comprising container means for containing a supply quantity of said particles, a particle collecting zone in open communication with said container means and having aperture means through which said particles are dispensed into the environment, magnet means in said zone adjacent said aperture means for attracting and retaining a predetermined quantity of said particles in said zone, and means for selectively controlling the quantity of particles collected into the environment.

2. A device as called for in claim 1, wherein said particles constitute a mixture of various sized ferrous filings.

3. A device as called for in claim 1, which includes means for selectively controlling the quantity of particles accumulated in the collecting zone.

4. A device as called for in claim 1, wherein the magnet means is disposed eccentrically within a non-magnetic housing, and wherein said magnet means is selectively adjustable for controlling the quantity of particles accumulated therein said collecting zone.

5. A device as called for in claim 4, wherein said non-magnetic housing comprises a cylinder having an elongate cavity offset from its longitudinal axis, said cavity containing said magnet means.

6. A device as called for in claim 5, wherein the aperture means includes a particle release aperture, and a screen plate is disposed between said collecting zone and release aperture, said screen plate having orifices therethrough through which the particles are propelled.

7. A device as called for in claim 6, wherein said release aperture further comprises an open-ended release hose in communication with said collection zone, and means for selectively closing said open-ended hose.

8. A device as called for in claim 7, wherein said closing means comprises an adjustable shut-off valve for controlling the flow through said hose.

9. A dispenser head as called for in claim 1, wherein the magnet means comprises a permanent magnet.

10. A device as called for in claim 1, which includes a compressible container in communication with said collecting zone for generating said flow of air when compressed.

11. A device as called for in claim 1, wherein the container means for containing a supply quantity of particles comprises an open ended, squeeze-type container, and wherein the particle collecting zone comprises a dispenser head on the open end of said container, said head including a discharge orifice through which particles propelled from the collecting zone are discharged.

12. A device as called for in claim 1, wherein the container means for containing a supply quantity of particles comprises an air tight container, and wherein the particle collecting zone comprises a member disposed in the lower portion of said container, said member including an elongate, particle-receptive chamber, said magnet means disposed in said member adjacent said chamber, and means for introducing the flow of air through said chamber to dislodge particles accumulated therein and propel said particles into the environment.

13. A device as called for in claim 12, wherein said member includes a particle-receptive throat in open communication with the interior of said chamber, and wherein particles housed within said container are gravity fed to said throat.

14. A device as called for in claim 13, which includes a non-magnetic air conduit disposed in spanning relationship with respect to said throat, and wherein the discharge end of said conduit terminates interiorly of said chamber, and wherein the inside diameter of said chamber is greater than the outside diameter of said air conduit for providing a particle passageway in open communication between said chamber and said throat.

15. A device as called for in claim 1, wherein said container means includes a low pressure air supply,
means for coupling said air supply to said means for
causing a flow of air, and a fill zone in communication
with said collecting zone for automatically accumulat-
ing particles in the vicinity of said collecting zone.
16. A device as called for in claim 15, wherein said
supply container further comprises a wheeled carriage.

17. A dispenser head for use with an open-ended,
squeeze-type container for providing a dispenser as-
sembly for releasing a controlled quantity of finite,
magnetic particles into the environment from said con-
tainer incident to the expulsion of air from the con-
tainer, said head constituting a particle collecting zone
including a discharge orifice; and magnet means dis-
posed interiorly of said head adjacent said discharge
orifice, said magnet means comprising an elongate,
non-magnetic member having an elongate, permanent
magnet housing therein.
18. A dispenser head as called for in claim 17,
wherein the head includes side walls and an end wall in
which the discharge orifice is located, and wherein said
non-magnetic member spans the side walls and extends
diametrically across the interior of said head.
19. A dispenser head as called for in claim 18,
wherein the permanent magnet is eccentrically dis-
posed relative to the longitudinal axis of said non-
magnetic member.
20. A dispenser head as called for in claim 19,
wherein the non-magnetic member is mounted for rota-
tion about its longitudinal axis relative to said head for
varying the location of the magnet with respect to the
discharge orifice.  * * * * *