DEVICE FOR FLUIDIZING STORED MATERIAL

Inventor: Douglas C. Steltz, Brookfield, Wis.
Assignee: Portec, Inc., Waukesha, Wis.

Filed: Mar. 24, 1972
Appl. No.: 237,913

ABSTRACT

A device for injecting a gas into bulk material stored within a vessel to enhance the flow characteristics of the material. The device includes a housing to be mounted within an opening in the wall of the vessel and having a connection to a source of gas under pressure. The housing supports a porous metal filter element which permits the flow of gas into the material confined within the vessel but prevents the escape of the material into the pressurized gas system. The housing is designed so that it can be attached to the vessel wall entirely from the exterior of the vessel.

5 Claims, 11 Drawing Figures
DEVICE FOR FLUIDIZING STORED MATERIAL

This application is a division of application Ser. No. 858,937, filed Sept. 18, 1969 now U.S. Pat. No. 3,656,812.

This invention relates to a device for fluidizing stored bulk material, and more particularly to a device for injecting a gas into bulk material stored within a vessel to enhance the flow characteristics of the material.

Bulk material, such as cement, grain, food products, and the like, are stored in various types of vessels such as bins, hoppers, silos, hopper cars, and the like. To enhance the flow and accelerate the discharge of the bulk material it is often desired to introduce air or other gas into the stored material. The air serves to fluidize the material thereby improving the flow characteristics of the material for discharge.

The present invention relates to an improved device for injecting a gas into material stored within a vessel such as a bin, hopper or silo, to enhance the flow characteristics of the material. More specifically the device includes a housing to be mounted within an opening in the wall of the vessel and having a connection to a source of air or other gas under pressure. The housing supports a porous metal filter element which permits the flow of gas into the stored material within the vessel but prevents the flow of the stored material outwardly into the pressurized gas system. The gas injected through the device of the invention is diffused into the confined material and acts to fluidize the material to improve its flow characteristics.

The porous metal filtering element provides a filtering media which is rigid and non-corrosive and has a porosity such that it will allow the desired gas flow into the vessel, but will prevent the material confined within the vessel from leaking into the pressurized gas system. Moreover the porous metal filtering element will resist contamination and will not become clogged with the stored material over extended periods of use.

The housing not only confines the filter element, but also provides an air tight seal with the vessel wall and provides a connection to the source of fluid under pressure.

The housing along with the porous metal filter element can be attached within the opening in the vessel wall entirely from the exterior of the vessel, so that it is readily adaptable for use with existing vessels. In the preferred method of installation, the housing can be attached to the vessel wall without drilling additional holes in the vessel wall, other than the hole through which the gas is adapted to pass. In other situations, the housing is provided with an outer sealing ring which can be attached to the vessel wall bordering the opening by sheet metal screws, when dealing with light gauge metal walls, or can be secured by welding, when the walls of the vessel are of substantial thickness.

Other objects and advantages will appear in the course of the following description.

The drawings illustrate the best mode presently contemplated of carrying out the invention.

In the drawings:

FIG. 1 is a side elevation of a bin containing a free flowing stored material and incorporating the aerating device of the invention;

FIG. 2 is a plan view of the outside surface of the aerating device as attached to the wall of a vessel with parts broken away in section;

FIG. 3 is a section taken along line 3—3 of FIG. 2;

FIG. 4 is a plan view of the inside surface of a modified form of the invention;

FIG. 5 is a section taken along line 5—5 of FIG. 4;

FIG. 6 is a plan view of the outside surface of a further modified form of the aerating device as applied to the wall of a storage vessel;

FIG. 7 is a section taken along line 7—7 of FIG. 6;

FIG. 8 is a plan view of the outside surface of another modified form of the invention;

FIG. 9 is a section taken along line 9—9 of FIG. 8;

FIG. 10 is a plan view of the outside surface of another modified form of the invention; and

FIG. 11 is a section taken along lines 11—11 of FIG. 10.

FIGS. 1—3 illustrate a storage vessel or bin 1 adapted to contain a bulk stored material. The bin 1 is supported on a suitable foundation 2 and includes a generally cylindrical sidewall 3 which is enclosed by a roof 4. Side wall 3 is provided with an opening 5 and the aerating device 6 of the invention is adapted to be secured within the opening 5.

While FIG. 1 illustrates the aerating device of the invention associated with a bin 1 it is contemplated that the aerating device can be utilized with any type of storage vessel such as a silo, hopper, railway car hopper, truck carrier, or the like.

As best illustrated in FIGS. 2 and 3, the aerating device 6 includes an outer housing 7 which is composed of a central dome-like portion 8 and a generally flat peripheral portion 9 which extends outwardly from the dome 8. The central portion of dome 8 is provided with an opening and a connector 10 is secured within the opening. A suitable conduit 11 is threaded within the connector 10 and connects the housing with a suitable source of gas, such as air, under pressure. While the drawing illustrates the conduit 11 being threaded with the connector 10, it is contemplated that the conduit can be connected in any suitable manner to the connector.

In addition to the outer housing 7, the aerating device also includes an inner annular housing 12 formed with an outer, generally flat peripheral portion 13 which is spaced inwardly from the peripheral portion 9 of outer housing 7. An annular gasket 14 is disposed between the peripheral sections 9 and 13, and a similar gasket 15 is located between the peripheral portion 13 of inner housing 12 and the outer surface of the side wall 3 of the vessel.

As best illustrated in FIG. 3, the inner housing 12 is provided with an annular flange 16 which terminates in an inwardly extending lip 17 bordering the central opening in the housing. According to the invention, a porous metal disc 18 is mounted between the peripheral portion 9 of the outer housing 7 and the lip 17 of the inner housing 12.

The porous metal disc 18 is formed of a rigid, non-corrosive metal, such as bronze or stainless steel, and is provided with a series of minute, interconnected voids or pores which provide labyrinth-type passages through the disc. The porous nature of the disc 18 enables the gas, such as air, to pass through the disc into the interior of the vessel 1, but due to the minute nature of the voids or pores in the disc the contained material...
3 is notable to pass outwardly through the disc to the exterior. To mount the device 6 within the opening 5 of the vessel, a series of generally L-shaped bolts 19 are employed. The inner end 20 of each bolt functions as a hook and engages the inner surface of the wall 3, while the outer end of each bolt extends through aligned openings in the peripheral portions 9 and 13, as well as in gaskets 14 and 15 and receives a nut 21. By threading down the nuts 21 on the ends of the bolts 19, the hooked ends 20 will be drawn tightly against the inner wall of the vessel to clamp the unit within the opening 5.

As shown in FIG. 2, the outer end of each bolt 19 is provided with a slot 22, and each slot 22 is disposed in alignment with the respective hooked end 20 of the bolt, thereby enabling the operator to determine the position of the hooked ends 20 by viewing the position of the slots 22.

To install the aerating device of the invention, the hooked ends 20 are rotated inwardly to a position where they will pass freely through the opening 5 in the vessel wall. With the gaskets pressed firmly up against the outer surface of the wall 3, each bolt 19 is rotated by inserting a screw driver within the slot 22 until the hooked end 20 is rotated to a position behind the sidewall 3. The end 20 is retained in this position by maintaining engagement of the screw driver with the slot 22, and while in this position, the nut 21 is threaded down onto the bolt 19 to firmly clamp the device to the wall 3 bordering the opening 5. When discharging the bulk material from the bin 1, air or other gas under pressure is introduced into the domed portion 8 of the outer housing and passes through the porous filter disc 18 into the interior of the vessel. The air acts to fluidize the stored material thereby aiding in the discharge of the material from the vessel.

FIGS. 4 and 5 illustrate a modified form of the invention. In this embodiment the aerating device includes a housing 23 composed of a central curved section 24 and a generally flat peripheral section 25. The peripheral section 25 is spaced from the outer surface of the sidewall 3 of the vessel by an annular gasket 26.

The central section 24 of housing 23 is provided with a threaded opening 27 and a conduit 28 is threaded into the opening and is adapted to be connected to a source of air or other gas under pressure.

As best shown in FIG. 5, the inner surface of the housing 23 is provided with a recess 19 and an annular shoulder 30 borders the recess. A porous metal filter disc 31, similar to disc 18 of the first embodiment, bears against the shoulder 30. To retain the disc 31 in position, the inner surface of the disc is provided with an annular recess 32 and a snap ring 33 is located within the recess 32 and is engaged with the groove 34 formed in the wall of the housing 23 bordering the recess 29. Engagement of the snap ring 33 with the groove 34 serves to maintain the disc 31 in firm bearing engagement with the shoulder 30.

The housing 23 is clamped to the side wall 3 of the vessel by a series of bolts 35 which are similar to bolts 19 of the first embodiment. As illustrated in FIG. 5, each bolt 35 is provided with a bent or hook-shaped inner end 36 which is adapted to bear against the inner surface of the sidewall 3. The outer end of each bolt 35 extends through aligned openings in the peripheral section 25 and gasket 26 and receives a nut 37. As previously described, threading down the nuts 37 on the bolts 35 will draw the housing 23 tightly against the sidewall 3 to firmly clamp the aerating device 6 to the vessel wall.

In operation, air of other gas under pressure, is introduced through the conduit 43 and passes through the porous metal filter disc 31 into the mass of stored material to fluidize the same and aid in the discharge of the material from the vessel.

FIG. 6 and 7 illustrate a further modified form of the invention in which the aerating device includes a housing 38 composed of a generally flat outer section 39 and a central section 40. As shown in FIG. 7, the outer section 39 includes a hub 41 which is internally threaded and receives the externally threaded central section 40.

Central section 40 is provided with a central opening 42 and a conduit 43 is threaded within the opening 42 and is connected to a suitable source of pressurized gas.

In the embodiment shown in FIGS. 6 and 7, the porous metal filter element 44 has a cup-shape and the inner open end of the element is secured by cement or other means within a recess 45 in the central section 41 of the housing. With this construction, the filter element 44 and the central section 40 are integral so that by unthreading the central section and withdrawing it from the outer section 39 the filter element can be removed for repair or replacement. The outer end of central section 40 has a hexagonal shape, to facilitate threading and unthreading.

To secure the outer section 39 of the housing to the vessel wall an annular gasket 46 is located between the section 39 and wall 3 and a series of sheet metal screws 47 extend through openings in the section 39 and are engaged with the wall 3.

The sheet metal screws 47 are utilized when the aerating device 6 is to be connected to a vessel having a relatively thin gauge wall.

The operation of the device shown in FIGS. 6 and 7 is similar to that previously described. Air introduced through the conduit 43 will pass through the filter element 44 and into the mass of the stored material to aerate the same. As the filter element is connected integrally to the central section 40 of the housing, the filter element can be removed from the vessel by unthreading the central section 40 from the outer section 39.

FIGS. 8 and 9 illustrate a further modified form of the invention which is similar to that shown in FIGS. 6 and 7 except that the unit of FIGS. 8 and 9 is particularly adapted to be connected to a vessel having a relatively heavy gauge wall. As illustrated in FIG. 9, the aerating device 6 includes an annular plate 48 which is welded to the outer surface of the wall 3 bordering the opening 5. The central opening of the plate 48 is threaded and a fitting 49 is threaded within the central opening. The outer end of the fitting 49 is provided with a hexagonal-shaped cap 50 and the cap is formed with a central opening which threadedly receives a conduit 51 adapted to be connected to a source of gas under pressure. In the embodiment shown in FIGS. 8 and 9, the filter element 52 has a cup-shape and is formed of a porous metal similar to that described with respect to filter element 18. As illustrated in FIG. 9, the open end of the filter element 52 is secured by adhesives or welding to the inner end of the fitting 49 so that the filter element 52 and the fitting 49 are integral.
With this construction the filter element 52 can be removed from the vessel by unthreading the fitting 49 from the plate 48.

The construction shown in FIGS. 8 and 9 is particularly adapted for use with vessels having a relatively heavy gauge wall. In this situation the support plate 48 can either be welded or connected by adhesives to the vessel wall.

FIGS. 10 and 11 illustrate another form of the invention in which the aerating device 6 includes a housing 54 composed of an outer section 55 and an inner annular section 56. The outer section 55 is generally curved and is provided with a nipple 57 which is adapted to be connected by conduit 58 to a source of air or other gas under pressure.

Both of the housing sections 55 and 56 are provided with annular flanges 59 and 60, respectively, and a gasket 61 is located between the flanges 59 and 60, while a second gasket 62 is located between the flange 60 of the inner housing section 56 and the outer surface of the wall 3. The housing is secured to the outer surface of the wall by a series of screws 63 which extend through the flanges 59 and 60 and are threaded into the wall 3.

As shown in FIG. 11, a thin porous metal membrane or disc 64 is clamped between the outer and inner housing sections 55 and 56. The porous metal disc 64 is similar in function and structure to disc 18 previously described, and air being introduced into the housing through the conduit 58 will pass through the disc 64 and into the mass of material within the vessel. However, the nature of the porous metal will prevent the stored material from passing outwardly through the disc 64 and into the pressurized gas system.

The porous metal filter element is rigid and noncorrosive and has a porosity such that it will allow air to pass inwardly in sufficient quantity to fluidize the bed of stored material, while preventing the stored material from passing outwardly. Moreover, the filter element resists contamination and will not become clogged over extended periods of service.

The filter element is contained within a housing which not only confines the filter element, but also provides a seal to the vessel wall and provides connection for the supply of the fluid to the vessel.

In some situations the housing is connected within the opening in the vessel wall without the necessity of drilling additional holes in the vessel or without the use of permanent fasteners or welding. In other situations, the housing can be attached to the vessel wall by sheet metal screws, when the vessel wall is of light gauge, or it can be attached by means of welding when the vessel wall is of heavy gauge.

The embodiments of the invention in which an exclusive property of privilege is claimed are defined as follows:

1. A device for supplying a gas to a bulk material contained with a vessel, said device being disposed within an opening in the vessel wall and comprising a housing having a gas inlet located on the exterior of the vessel and a gas outlet communicating with the interior of the vessel, attaching means for sealing the peripheral portion of the housing to the wall of the vessel bordering the opening therein, fluid connecting means connected to said inlet for supplying a gas under pressure to the housing, and a gas permeable porous metal filter element disposed across said outlet, said porous metal filter element being provided with a series of minute interconnected pores to provide said element with a permeability such that air can pass freely through the element to the interior of the vessel but the contained material will be prevented from passing through the element to the pressurized gas system, said housing is provided with a generally flat peripheral portion attached to the outer wall of the vessel, said attaching means comprises a series of rotatable connecting members extending through the flat peripheral portion and engaged with the inner wall of the vessel, each of said connecting members having an inner end portion disposed to be rotated into engagement with the inner surface of the vessel wall bordering the opening.

2. The apparatus of claim 1, wherein each connecting members comprises a generally L-shaped bolt having an inner radially extending end disposed to engage the inner surface of the wall of the vessel and an axially extending portion extending through an aperture in the peripheral portion of the housing, and clamping means engageable with the outer end of the axially portion of each bolt for drawing the radially extending end of each bolt into tight engagement with the vessel wall.

3. The apparatus of claim 2, and including indicating means associated with the outer extremity of the axially extending portion of each bolt for visually indicating the position of said radially extending end of said bolt.

4. In a storage structure, a vessel to contain a generally free flowing bulk material and having an opening in the wall thereof, a fluidizing device disposed within the opening in the vessel wall and comprising a housing having an inlet located on the exterior of the wall and having an outlet disposed in communication with the interior of the vessel, attaching means for attaching the peripheral edge portion of said housing to the outer wall of the vessel, connecting means for connecting the inlet to a source of gas under pressure, and a rigid porous metal filter element carried by the housing and enclosing said outlet, said filter element being provided with a series of interconnected voids to provide the element with a porosity such that the gas will be permitted to freely pass through the element into the interior of the vessel while the bulk material will be prevented from passing outwardly through said element, said attaching means comprises a series of generally L-shaped connecting members rotatably mounted within apertures in the peripheral portion of said housing, each of said connecting members comprising a radially extending portion disposed in engagement with the inner surface of the vessel wall and comprising an axially extending portion extending through an aperture in the peripheral portion of said housing, the axially extending portions of said connecting members lying on a circle having a lesser diameter than the diameter of the opening in the vessel wall whereby the connecting members, with the radially extending portions being rotated to an inward position, can be inserted within the opening in the vessel wall and means engageable with the outer extremities of the axially extending portions for drawing the radially extending portions of said members into tight engagement with the inner surface of the vessel wall.

5. The apparatus of claim 4, wherein the last named means comprises nuts threaded on the outer ends of the axially extending portions.