# United States Patent [19]

**Hurst**

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[54] **METHOD AND APPARATUS FOR MIXING A POWDER WITH A FLOWABLE SUBSTANCE**


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[52] **U.S. Cl.** ..... **259/4,** 259/148, 259/151

[51] **Int. Cl.** ..... **B01f 15/02**

[58] **Field of Search** ..... 259/4, 18, 97, 36, 147, 259/151, 148



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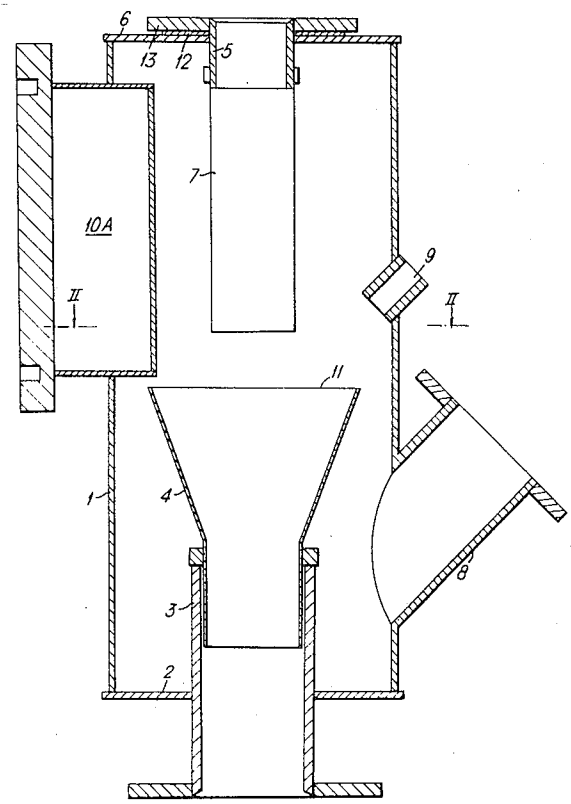
[57] **ABSTRACT**

A method and apparatus for mixing powder e.g. lime in a flowable substance, such as sewage sludge, in which the flowable substance is introduced into a mixing chamber having an outlet, at a level below the outlet, in such a way that the flowable substance is induced to flow out of the outlet in a vortex flow, and the powder is introduced into the vortex flow.


**10 Claims, 5 Drawing Figures**



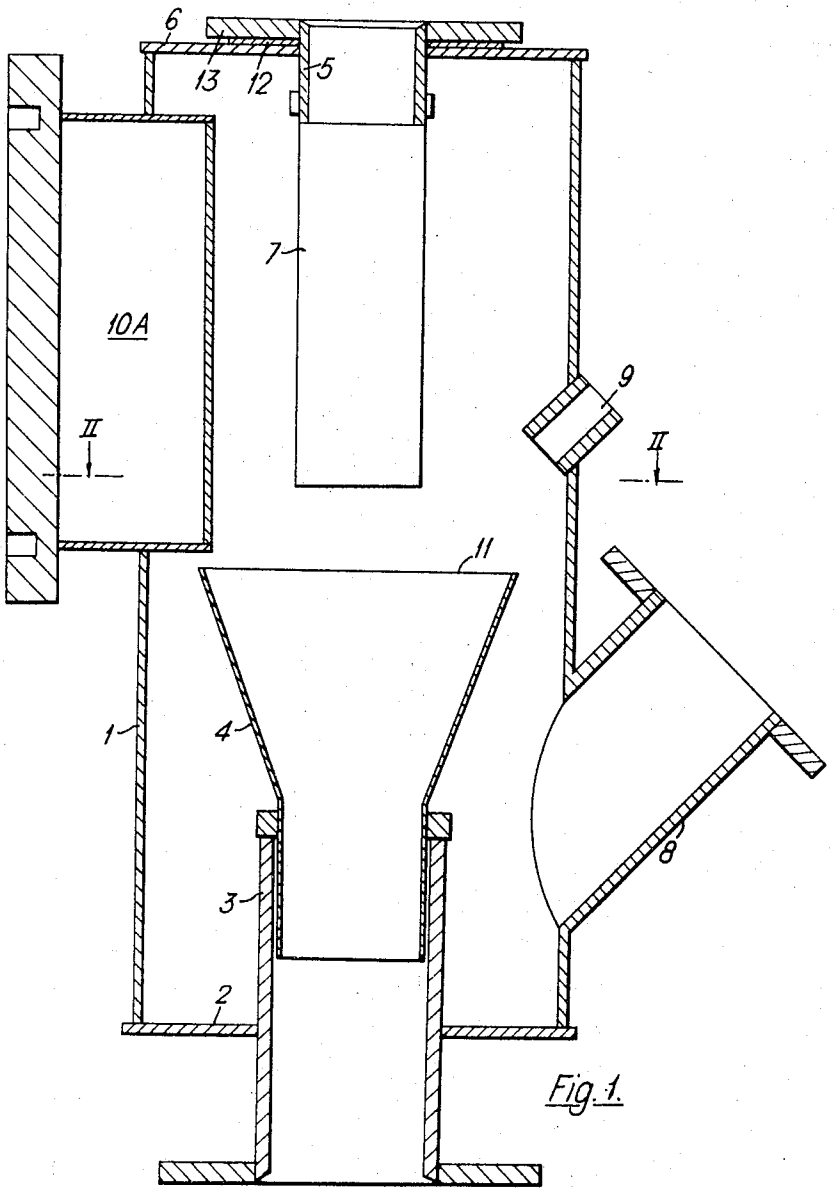



Fig. 1.

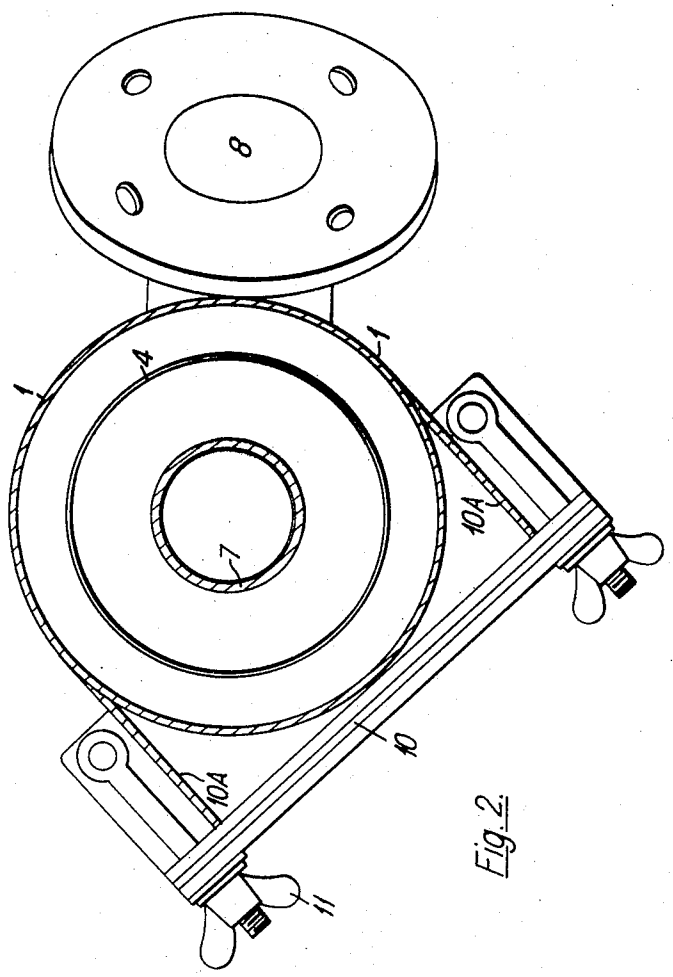



Fig. 2

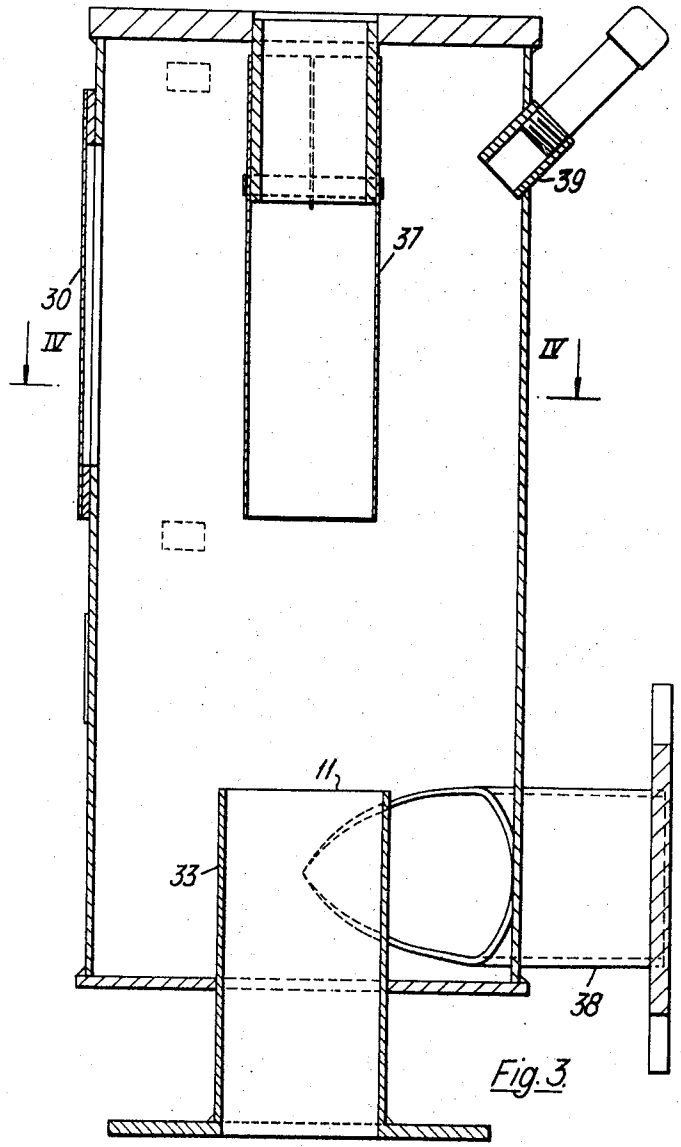



Fig. 3

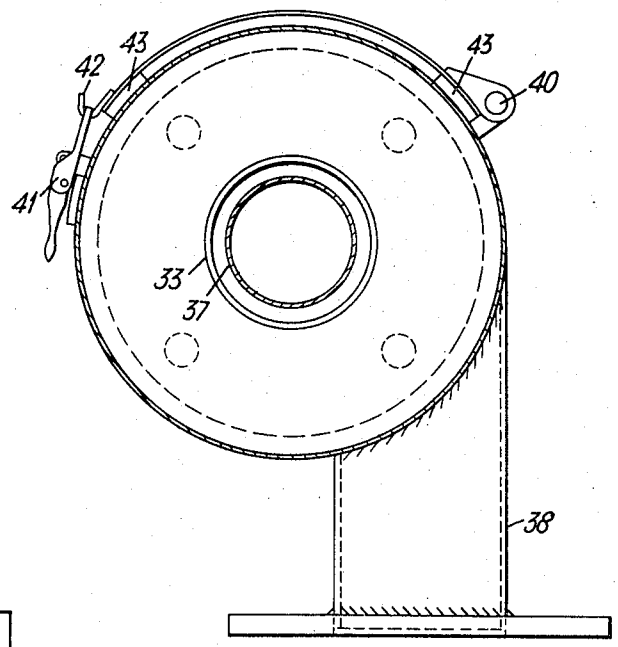



Fig.4.

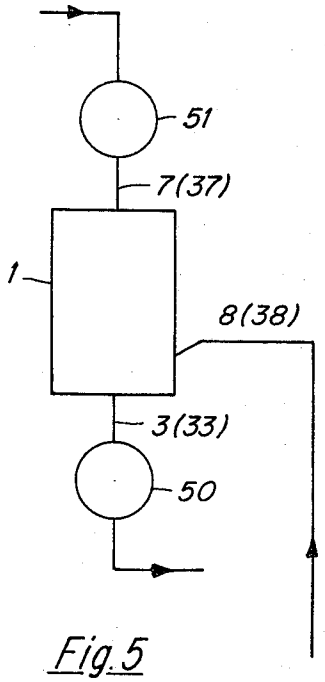



Fig.5

# METHOD AND APPARATUS FOR MIXING A POWDER WITH A FLOWABLE SUBSTANCE

This invention relates to a method and apparatus whereby a powder can be added to a flowable substance such as a liquid, slurry or sludge and mixed therewith. The invention is particularly but not exclusively applicable to the adding of lime to sewage sludge in such a way that proper mixing of the lime and sludge occurs.

According to one aspect of the present invention there is provided a method of mixing a powder with a flowable substance wherein a vortex is generated in the flowable substance and the powder is introduced into the vortex.

According to a second aspect of the present invention there is provided apparatus for mixing a powder with a flowable substance comprising a mixing chamber including an inlet for a flowable substance, an outlet having an opening in the chamber and through which the flowable substance may pass in a vortex flow, and an inlet for powder which is above the outlet, to direct powder into the vortex flow.

There is also provided, according to the invention, a mixing installation including such an apparatus and a pump connected to the outlet to provide suction thereat to promote vortex flow.

The axes of the outlet and inlet for powder are preferably vertical and advantageously coaxial.

The flowable substance inlet is suitably below the level of the opening of the outlet. The outlet may comprise a pipe projecting into the chamber with the opening in the chamber. The pipe may be a plain-ended cylindrical pipe, or frusto-conical at its end in the chamber, or may have a funnel. The powder inlet may also be a pipe extending into the chamber and must be sufficiently vertically spaced above the opening of the outlet so that at all times the inlet pipe is not dampened by flowable substance if it contains liquid passing through the outlet.

The flowable substance inlet may be downwardly inclined. The inlet may be disposed so that its axis intersects the longitudinal axis of the chamber, or with its axis offset from the longitudinal axis of the chamber, preferably so that a portion of the inflow is tangential to the inner surface of the chamber at the inlet. While the provision of the offset axis may assist vortex flow, it is not essential, because as the substance flows out through the outlet vortex motion will occur in any case.

The pump of the mixing installation is suitably a pump with an eccentric rotor. There may be a powder pump in a supply line to the powder inlet to urge powder towards that inlet or any other suitable dry powder feeder can be used. The mixing chamber may have a circular cross-section, and it may have a planar or curved window which is suitably removable for the purposes of cleaning. The chamber may also have an access hole located above the level of the outlet to allow access to the outlet.

As the flowable substance passes down the outlet in a vortex flow, dry powder is dropped into the eye of the vortex and is effectively mixed thereby, mixing being completed in the case of the mixing installation during passage through the pump. The pump enhances the vortex action by creating a vacuum in the outlet and in the mixing chamber.



In order that the invention may be more readily understood, the following description is given, merely by way of example, with reference to the accompanying drawings, in which:

FIG. 1 is a vertical section of one form of mixing chamber incorporated in apparatus according to the invention;

FIG. 2 is a section along the line II—II of FIG. 1;

FIG. 3 is a vertical section of a second form of mixing chamber incorporated in apparatus according to the invention;

FIG. 4 is a section along line IV—IV of FIG. 3; and

FIG. 5 is a schematic view of apparatus according to the invention.

As shown in FIGS. 1 and 2, the mixing chamber has a generally cylindrical housing 1, which is suitably vertically disposed. Through a bottom wall 2 of the housing, there extends an outlet pipe 3 and into the upper end of this pipe 3, there is fitted a funnel 4 which has a frusto-conical upper part terminating in an opening 11 and a cylindrical lower part within the pipe 3. Coaxial with the outlet pipe 3 is a powder inlet pipe 5 passing through an upper wall 6 of the chamber. Attached to, coaxial with, and depending from the inlet pipe is an extension 7 which terminates at a short distance above the top of the funnel 4. A downwardly inclined second inlet channel 8 passes through a side wall of the chamber and terminates below the upper end of the funnel 4. This second inlet is for a flowable substance such as liquid, sludge or slurry to be passed through the mixing chamber and mixed with a powder passed through the inlet 5, and its axis intersects the vertical axis of the mixing chamber. An access opening 9 is provided in the wall of the chamber above the inlet 8 and is inclined so that it may be used to allow a water spray nozzle to be screwed thereto for cleaning the funnel if this should prove necessary. The opening 9 may also be used to permit a probe to be used to clear the funnel 4 if this becomes blocked, or to accommodate a vacuum gauge tapping. A window 10 is provided opposite the opening 9, to allow mixing to be observed, and this window is removable to allow access to the interior of the chamber. The window 10 is held in position by wing nuts 11, and closes a rectangular opening defined by walls 10A which are tangential to the cylindrical body 1 of the mixing chamber. A flange 13 is bolted to the top wall 6 of the chamber and there is a gasket 12 between this flange, the top wall 6 and the inlet pipe 5.

The embodiment of FIGS. 3 and 4 is basically similar, and only the points of difference need be described.

An outlet pipe 33 terminates at its upper end in a circular opening 11 of the same radius as the rest of the outlet pipe, rather than being provided with a funnel as in FIG. 1.

The inlet 38 is perpendicular to the longitudinal axis of the chamber while its axis is offset from the axis of the chamber. The outermost part of the inlet 38, which is circular, is tangential to the wall of the chamber, as may be seen in FIG. 4. This arrangement of the inlet assists in creating vortex flow, although it is not essential for this purpose.

The window 30 is in the form of a part cylinder which, when this window is closed, is coaxial with the mixing chamber. The window has hinges 40 at one side, allowing it to be pivoted on a longitudinal line of the cylinder, and an overcentre catch 41 to engage a hook

42 on the other side of the window is provided on the cylinder wall. A seal 43 surrounds the window.

Access opening 39 is in this embodiment located near the top of the chamber.

In a mixing apparatus according to the invention, as shown in FIG. 5, a mixing chamber as shown is attached by the outlet tube 3,33 to a pump 50, and preferably a powder pump 51 is located in a supply line to the inlet pipe 5,35.

When the device is used, for instance, for adding lime to sewage sludge, the sludge may be pumped or possibly may flow by gravity through the inlet 8, 38 to the chamber and as the level of the sludge rises to above the top of the funnel 4, (outlet 33), it will be sucked down the outlet 3,33 the suction causing it to assume a vortex flow within the funnel 4 and/or outlet 3,33. Simultaneously, lime is passed through the inlet 7,37 to fall into the eye of the vortex and mixing occurs due to the vortex motion induced by the suction. Mixing is further promoted as the mixture passes through the pump attached to the outlet 3,33 particularly if, as is suitably the case, this pump is an eccentric rotor pump. On being discharged from the pump, the sludge/lime mixture will be dust free.

I claim:

1. A method of mixing powder with a flowable substance including the steps of introducing substance into an enclosed mixing chamber, sucking the substance downwardly out of the chamber through a discharge passage thereby to generate a vortex in the flowable substance exiting from the chamber and simultaneously to create a partial vacuum in the chamber and introducing the powder into the vortex thus generated at a level above the discharge passage.

2. A method as claimed in claim 1 wherein the flowable substances is introduced into the mixing chamber at a level below said discharge passage.

3. Apparatus for mixing powder with a flowable substance said apparatus comprising an enclosed mixing chamber, a discharge passage having an opening in said chamber, a first inlet for introducing flowable substance into said chamber, means to suck the flowable substance downwardly out through said discharge passage thereby to induce a vortex flow therein as said flowable substance is sucked through said discharge passage and simultaneously to create a partial vacuum in said chamber, and a second powder inlet positioned at a level above said discharge passage opening to direct powder into said vortex flow.

4. Apparatus as claimed in claim 3, wherein said second inlet and said discharge passage are coaxial and vertical.

5. Apparatus as claimed in claim 3, wherein said first inlet is below the level of the opening of said discharge passage.

6. Apparatus as claimed in claim 5, wherein said discharge passage is an upstanding pipe projecting vertically upwardly into said enclosed mixing chamber.

7. Apparatus as claimed in claim 3, wherein said second inlet comprises a pipe extending into said chamber and terminating above said discharge passage opening.

8. Apparatus as claimed in claim 3 and further comprising an access opening above said discharge passage opening and means to close said access opening.

9. Apparatus as claimed in claim 3 and further comprising an openable window above said outlet opening.

10. Apparatus as claimed in claim 3, wherein said mixing chamber is a circular cross-section wherein said first inlet is directed along an axis offset from the axis of said mixing chamber whereby, in use, said flowable substance flows substantially tangentially into said mixing chamber.

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