

Aug. 11, 1942.

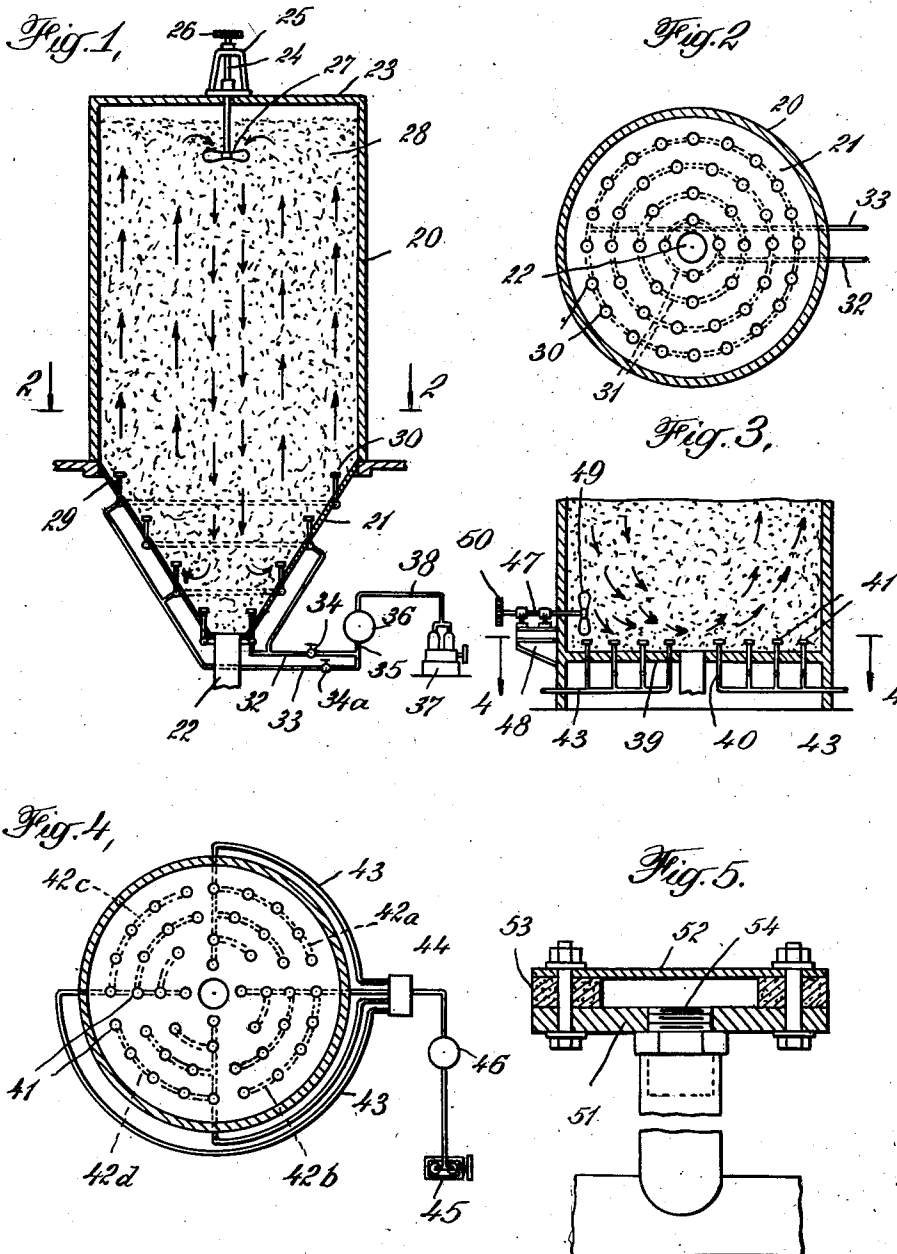
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2,292,897

METHOD AND APPARATUS FOR MIXING

Filed Jan. 17, 1941

2 Sheets-Sheet 1



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Fig. 6,

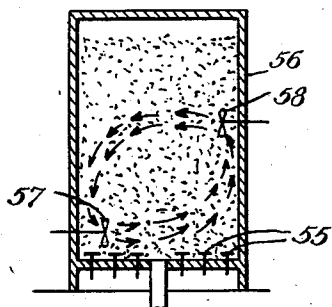


Fig. 7,

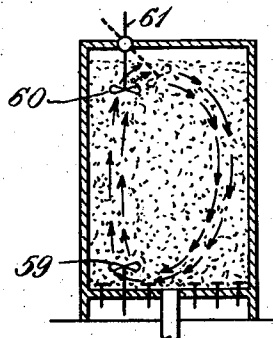


Fig. 8

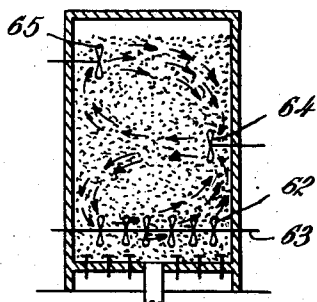


Fig. 9,

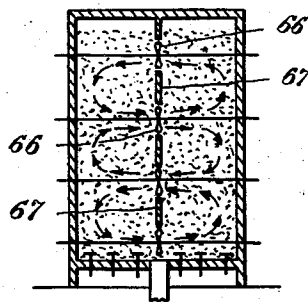


Fig. 10,

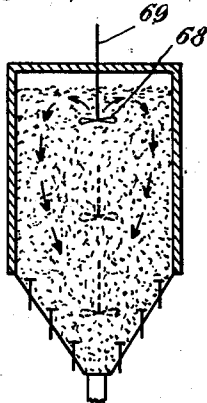


Fig. 11,

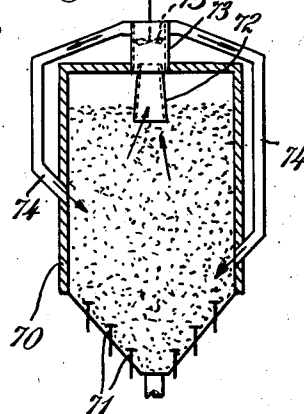
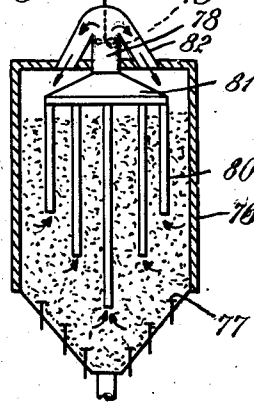


Fig. 12,



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METHOD AND APPARATUS FOR MIXING

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4 Claims. (Cl. 259-4)

This invention relates to the mixing and blending of finely divided pulverulent materials, such as ground cement raw materials, cement, and the like. More particularly, the invention is concerned with a novel method by which such materials may be mixed and blended for the purpose of rendering and maintaining them homogeneous and an apparatus by which the method may be advantageously practised.

Finely divided pulverulent materials must frequently be mixed and blended, as, for example, in the preparation of a mixture of ground cement raw materials suitable for burning into clinker. Heretofore such materials have been mixed either pneumatically or mechanically and both methods are objectionable. If the mixing is carried on entirely by aeration of the materials, the large quantities of air required make the process uneconomical, while if the operation is carried on mechanically, as by means of agitating devices, the necessary apparatus is so large as to be expensive and complicated.

The present invention is directed to the provision of a method for mixing and blending pulverulent materials which overcomes the disadvantages of the methods heretofore used and it involves introduction of air into the materials in an amount sufficient to render them fluent and the formation and maintenance of circulating currents within a body of the materials in such fluent condition. The materials may be rendered fluent in a preliminary operation and the circulating currents then set up within a body of the materials or, if desired, the devices for introducing the air and for setting up and maintaining the currents may be started simultaneously. In either case, the introduction of air may be discontinued after the materials have reached the fluent condition or the introduction of air may be continued for the purpose of setting up and maintaining additional currents. The method may be employed either to mix materials or to maintain already mixed materials in homogeneous condition and the mixing operation may, if desired, be carried on during the charging and discharging of the container.

The new method may be advantageously practised by means of an apparatus which includes a container, such as a silo, which is provided with one or more propellers mounted for rotation within the container in contact with the material therein and driven by means capable of reversing the direction of rotation of the propellers. The container is also provided with a plurality of nozzles through which compressed air may be

introduced into the body of materials therein and, preferably, the nozzles are supplied with air by control means operable to change the points of air introduction, as desired. The propellers set up circulating currents within the body of materials in the container and by changing the points of air introduction and altering the direction of rotation of the propellers, the paths of the currents may be changed so that a thorough mixing and blending of the contents of the container are obtained.

For a better understanding of the invention, reference may be had to the accompanying drawings, in which

Fig. 1 is a vertical section through one form of apparatus by which the new method may be practised;

Fig. 2 is a sectional view on the line 2-2 of Fig. 1;

Fig. 3 is a fragmentary vertical sectional view of a modified construction;

Fig. 4 is a sectional view on the line 4-4 of Fig. 3;

Fig. 5 is a sectional view through one form of air nozzle that may be employed;

Figs. 6 to 10, inclusive, are diagrammatic vertical sectional views showing different arrangements of the propellers and air nozzles that may be employed; and

Figs. 11 and 12 are vertical sectional views of different forms of apparatus constituting modifications of that illustrated in Fig. 1.

The apparatus illustrated in Fig. 1 comprises a silo having a cylindrical wall 20 and a conical bottom 21 provided with a discharge outlet 22. The silo is provided with a suitable inlet opening (not shown) and extending through the top wall 23 thereof is a shaft 24 mounted in bearings in a frame 25. The shaft is driven in any suitable way, as by means of a gear wheel 26, and at its lower end, carries a propeller 27 lying within the body of materials 28 within the silo.

Extending through the bottom of the silo are air pipes 29 leading to nozzles 30 and, in the construction shown, there are four circular sets of nozzles, with the nozzles of the different sets lying in different levels. The pipes 29 of the nozzles of each set are connected by circular supply pipes 31 supplied with air by lines 32 and 33. The line 32 leads to the circular pipes for the innermost set of nozzles and the second set outwardly therefrom, while the pipe 33 supplies the second and fourth circular pipes starting from the center. The lines 32, 33 are provided with control valves 34, 34a and beyond the con-

trol valves, the lines are connected by a single line 35 to a separator 36 for water and oil. Compressed air is supplied by a compressor 37 through a line 38 leading to the separator.

In the practise of the process by the apparatus illustrated in Fig. 1, the body of materials within the silo is first rendered fluent and, for this purpose, both control valves 34, 34a are opened so that air is introduced through all of the nozzles, and, at the same time, the propeller is started. The introduction of air through all of the nozzles continues until the material reaches the desired fluent condition and, thereafter, one of the control valves is shut and air flows through only two of the sets of nozzles. As illustrated in Fig. 1, air is being introduced through the line 33 so that the nozzles in the second and fourth sets outward from the center are active. The introduction of air through these nozzles, together with the action of the propeller, causes the formation of currents within the body of material, as indicated by the arrows, and after such currents have been established and maintained for a suitable period, valve 34a is closed and valve 34 is opened. Thereafter, upwardly flowing currents are established in the body of materials in line with the nozzles of the first and third sets outward from the center, the material flowing upward along such paths being caused to flow down through the center of the body by the propeller. A variation in current flow may also be obtained by reversing the direction of rotation of the propeller and in practise, the direction of rotation of the propeller is periodically changed and the valves 34, 34a are alternately opened and closed. If desired, the valves may be replaced by an automatic air distributor which periodically changes the flow from one air supply line to the other.

In the construction illustrated in Figs. 3 and 4, the silo has a flat bottom 39 through which pass pipes 40 terminating in nozzles 41. The nozzles are arranged in sets 42a, 42b, 42c, 42d, each set occupying a quadrant, and the nozzles in the several sets are supplied through lines 43 leading to a distributor 44 supplied by compressed air by a compressor 45, an oil and water separator 46 being interposed in the supply line between the compressor and distributor. The distributor operates to supply air to the sets of nozzles in different ways, as, for example, air may be supplied first to the sets 42a and 42b and thereafter to the sets 42c and 42d, or, if desired, the sets 42a and 42c may be supplied at the same time, after which, the nozzles in the sets 42b and 42d become active.

A shaft 47, mounted in bearings on a bracket 48 attached to the wall of the silo, extends through the wall of the silo and carries a propeller 49 on its inner end. Outside the silo, the shaft is provided with a gear wheel 50 by which it may be driven and, during the operation of the apparatus, the propeller is rotated, first in one direction and then the other, and air is supplied to the sets of nozzles in alternation so that circulating currents within the body of materials are set up and the direction of the currents and their paths are varied from time to time.

The nozzles employed in the various forms of apparatus are preferably so constructed that the air enters the material in a state of fine division and one type of nozzle suitable for the purpose is illustrated in Fig. 5. The nozzle comprises a pair of metal plates 51 and 52 bolted together with an annular strip of film or similar porous

material 53 clamped between the plates along their periphery. The plate 51 has a central opening 54 and air is supplied through the opening to the space between the plates, whence it escapes through the felt.

In the apparatus illustrated in Fig. 6, air nozzles 55 are mounted in sets to introduce air at the bottom of the container 56 and propellers 57 and 58 are mounted to rotate on horizontal axes within the body of material in the container. Propeller 57 lies near the bottom of the container and propeller 58 at a higher level. With this arrangement, a circulating current may be set up along the path indicated by the arrows and by reversing the direction of rotation of the propellers and supplying air to sets of nozzles alternately, the direction of flow and the paths of the circulating currents may be varied as desired.

The apparatus illustrated in the Fig. 7 construction is similar to that shown in Fig. 6 except that it includes propellers 59 and 60 disposed on vertical axes, the shaft 61 for the propeller 60 being mounted adjustably so that the axis of rotation of the propeller may be varied angularly as illustrated. With this construction, the materials may be circulated along different paths within the body in the container by changing the direction of rotation of the propellers, the angular position of shaft 61, and the points of introduction of the air.

In the construction shown in Fig. 8, a plurality of propellers 62 are mounted on a horizontal shaft 63 near the bottom of the container and other propellers 64, 65 are mounted for rotation on horizontal axes at different levels upward therefrom. Here again, the variations in the circulating flow may be obtained by varying the action of the propellers and altering the points of introduction of the air.

In the construction shown in Fig. 9, there are four propellers 66 rotating on horizontal axes and lying on the vertical center line of the container, one above the other. Between the propellers, baffles 67 are provided to control the path of the circulating currents.

In the construction shown in Fig. 10, the apparatus is similar to that illustrated in Fig. 1, except that the propeller 68 is mounted in a shaft 69 which is movable vertically so that the position of the propeller within the body of materials may be changed as desired.

In the Fig. 11 construction, the apparatus includes a container consisting of a container body 70 and a pipe system. The container body has a conical bottom provided with sets of air nozzles 71 to which air may be supplied in different ways as described above. The body has an opening at the top and a pipe 72 extends down into the body of materials through the opening. Leading upward from the opening is a pipe 73 connected by pipes 74 which lead to openings in the side wall of the body at different levels. Within the pipe 73 is a propeller 75 and by the action of the propeller and of the air injected through the nozzle 71, material may be drawn upward through the pipes 72, 73 from the interior of the body and returned thereto at different points through the pipes 74.

In the construction shown in Fig. 12, the container body 76 has a conical bottom on which are mounted air nozzles 77. The top of the body has an opening through which extends a pipe 78 containing a propeller 79. Within the body are vertical pipes 80 starting at different levels and leading upward to a casing 81 from which

the pipe 78 leads. The upper end of pipe 78 is then connected by pipes 82 which discharge through openings in the container body top. With this arrangement, the propeller, assisted by air injected through the nozzles 77, causes an upward flow of the material through the pipes 80 and the material passes through casing 81, pipe 78, and pipes 82 to be returned to the top of the body of materials within the container. By varying the supply of air to the nozzle, variations in the flow of material in the circulating streams may be effected and by extending pipes 82 down through the top of the container and into the body of material therein, the propeller may be reversed so that materials flow upwardly through the pipes 82 and return through the pipes 80.

With all of the constructions illustrated, the mixing and blending of the material are effected economically, since only small quantities of air are needed and the propulsion of the fluid-like aerated material does not involve large power consumption. In some instances, the material supplied to the container may be in aerated condition as a result of the means employed for transporting it thereto. In that event, no initial aeration of the material in the apparatus is required and the air employed maintains the aeration and increases the effectiveness of the mixing and blending action.

I claim:

1. Apparatus for mixing pulverulent materials in aerated condition and capable of flowing which comprises a container for a body of the materials, a propeller within the container rotating in contact with the materials and effective to produce circulating currents within the body, a plurality of concentric sets of nozzles in the lower portion of the container for introducing air into the body of materials therein, and means for supplying air to each set of nozzles, each of said air-supplying means being independently controlled.

2. A method of mixing dry pulverulent mate-

rials which comprises aerating the materials to render them fluent by introducing air into a body of the materials at a number of points distributed throughout the area of the lower portion of the body of materials, mechanically and pneumatically propelling the aerated and fluent materials, the mechanical propelling force being applied in a direction and at such point or points as to maintain circulating currents of the aerated materials within the body thereof, and periodically altering the paths of said circulating currents by changing the direction in which the mechanical and pneumatic propelling forces act upon the materials.

3. Apparatus for mixing pulverulent materials in aerated condition and capable of flowing which comprises a container for a body of the materials, a shaft mounted for rotation within the container, a propeller mounted on the shaft within the container and adapted to rotate in contact with the materials and being effective to produce circulating currents within the body, a mounting for the shaft permitting it to be moved longitudinally so that the position of the propeller within the container may be varied, a plurality of concentric sets of nozzles in the lower portion of the container for introducing air into the body of materials therein, and means for supplying air to each set of nozzles, each of said air-supplying means being independently controlled.

4. Apparatus for mixing pulverulent materials in aerated condition and capable of flowing which comprises a container for a body of the materials, a propeller within the container rotating in contact with the materials and effective to produce circulating currents within the body, a plurality of sets of nozzles in the lower portion of the container for introducing air into the body of materials therein, and means for supplying air to each set of nozzles, each of said air-supplying means being independently controlled.

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