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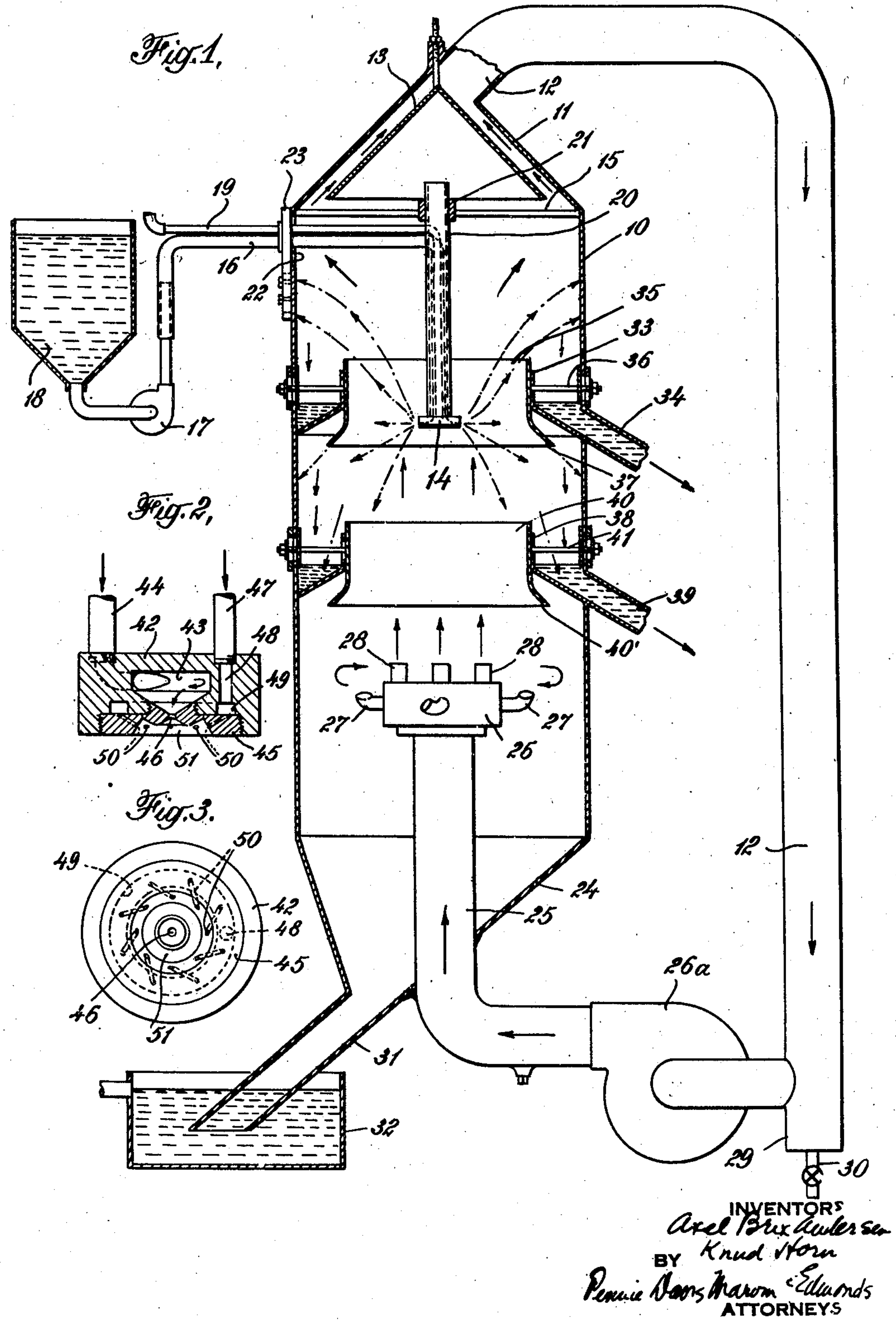

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AIR SEPARATION METHOD FOR SLURRY SEPARATION

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This invention relates to the treatment of material in slurry form for the purpose of separating the material into fractions of different particle size and is concerned more particularly with a novel method for effecting such separation and an apparatus by which that method may be advantageously practiced. The new method may be used in the treatment of slurries produced in various industries in which wet grinding is used, as, for example, in the cement industry in the preparation of the raw materials to be burned into clinker, the mining industry, etc. For purposes of explanation, the use of the new method in the treatment of cement raw material slurry will be illustrated and described in detail, but it will be evident that the utility of the invention is not limited to the treatment of a slurry of that particular kind.

In closed circuit grinding as practiced in the cement and mining industries, it is essential that all particles ground to the required fineness be removed from the slurry circulated through the mill. Also, in a cement raw material slurry of normal fineness, the size of the individual grains varies from 90 microns to less than 1 micron and the separation of the material into fractions containing particles of different size is necessary or desirable for various reasons. Some slurries contain substantial quantities of slimes and the removal of such slimes may be desirable in order to facilitate other steps in the separation process or because the slimes contain impurities which should be removed.

At the present time, apparatus of various kinds, such as centrifuges, bowl classifiers, and hydroseparators, are used in the separation of slurries into fractions containing particles of different size, but such apparatus is frequently large and expensive and the use of certain types of such apparatus requires dilution of the slurry with large amounts of water. After treatment in such apparatus, the excess water should be removed from the fractions, which are ultimately to be burned, in order that fuel may be conserved, but it is often difficult to carry on such dewatering with the result that the material contains an amount of water in excess of that required to make it pumpable.

In some instances, the slurry contains particles of the same weight and size but of different composition and, in that event, flotation may be employed to separate the particles of different composition. In order to facilitate flotation, the slurry is usually deslimed in a preliminary operation, although, in some instances, flotation

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of slime material has been practiced. It is not certain, however, that the flotation of slimes is of general application. Flotation processes depend on the use of reagents which coat the particles selectively and, to obtain the best results, the reagent used must be well mixed with the slurry, the flotation time should be as short as possible in order that the reagent will not coat both the concentrate and the reject particles, and the colloidal effect of extremely fine particles should be eliminated, for example, by the addition of a dispersing agent. As these requirements are contradictory, they cannot all be fulfilled on conventional flotation machines and the process is, therefore, somewhat inefficient.

The present invention is directed to the provision of a novel method, by which slurry may be treated to produce fractions containing particles of different size without excessive dilution of the slurry or the use of large and expensive apparatus. The method depends for its functioning on the breaking up or atomization of the slurry into drops of fine size, which may be particles with a thin coating of moisture thereon or, in some instances, entirely of water. The slurry is atomized into a current of air and the drops are suspended in the air for a longer or shorter time, depending on their size and specific gravity. The drops thus fall out of the current of air at different places and fractions of the slurry containing particles of different size can, accordingly, be collected at different points along the path of flow of the current.

The method may be conveniently practiced by creating a current of air through an enclosed space and discharging the slurry into or across the air current by atomizing the slurry by means of air under pressure or by mechanical means only. The fractions of the slurry are then collected at the boundary of the space at points at different distances from the place where the atomization occurs. A convenient form of apparatus for the purpose includes a vertical chamber into which air under pressure is introduced near the lower end to flow upwardly and escape at the top. The slurry is atomized by a suitable nozzle mounted within the chamber between the ends thereof and the spray so formed is discharged substantially horizontally across the path of the upwardly flowing current. The air steam suspends the lighter particles so that they travel upwardly and outwardly toward the wall of the chamber and may be collected along the chamber wall at a level above that of the atomizing nozzle, while the heavier particles fall through the air stream and are collected along the wall of the chamber at lower levels. In the use of such apparatus, the air may be introduced under pressure to create a stream of such velocity that the lightest drops, which will include drops of water and slimes, will be carried out of the chamber, so that desliming and dewatering will be effected.

In the treatment of a slurry which contains particles to be separated, which are of the same size and specific gravity but of different materials, the slurry may be mixed with flotation reagents which will selectively coat the particles of the different materials, the reagents used being collecting and frothing agents commonly employed in flotation practice and well known to the art. The mixing is preferably effected immediately ahead of the atomizing nozzle, by which the mixture is atomized and the individual particles set free. The reagents adhere to the particles of one type only so that, in the atomization, the coated particles acquire a surrounding air bubble which lowers their specific gravity and results in their suspension in the air stream for a longer time than the particles not coated by the reagents. Because of this difference in the specific gravities of the coated and uncoated particles, they can be separated according to the method in the same way as uncoated particles of different specific gravities.

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

Fig. 1 is a view in vertical section of apparatus which may be used in the practice of the new process;

Fig. 2 is a sectional view of a modified type of nozzle; and

Fig. 3 is a bottom plan view of the nozzle shown in Fig. 2.

The apparatus illustrated includes a vertical chamber 10 which may be made of any suitable material, such as sheet metal, and is provided with a conical top 11 from which leads an outlet conduit 12. A baffle 13 is mounted within the top in front of the discharge opening to intercept the outflowing air and create turbulence which will permit particles carried by the air stream to drop out of the stream.

An atomizing nozzle 14 is mounted within the chamber in any suitable manner, as on cross arms 15, and the nozzle may be of conventional type and atomize either by mechanical means only or by means of compressed air. The nozzle illustrated is of the latter type and it is supplied with slurry through a line 16 leading from a pump 17, which receives slurry from a tank 18 at any convenient location. Compressed air for effecting atomization of the slurry is supplied to the nozzle through a line 19 and the nozzle is provided with a multiplicity of discharge openings and discharges the slurry outwardly substantially horizontally, as, for example, in the form of a flat cone.

The nozzle is mounted on a shank 20 in a supporting member 21 on the arms 15 and may be raised or lowered, as may be desired. The pipes 16 and 19 extend outward from the nozzle through an opening 22 in the wall of the chamber and pass through a plate 23 which closes the opening and may be adjusted up or down as the nozzle is raised or lowered.

At its lower end, the chamber 10 is formed with a hopper-like bottom 24 through the wall of which extends an air inlet conduit 25 leading to a main discharge head 26 provided with a number of nozzles 27, 28. The nozzles 27 direct air streams in a generally upward and tangential direction, while nozzles 28 direct the air upwardly. The air conduit 25 is connected to the discharge outlet of a fan 26a, the intake of which is connected to the conduit 12, so that the air withdrawn from the chamber may be recirculated. The conduit 12 is provided near its lower end with a collecting trap 29 having a valved outlet 30 through which slurry, which has been carried out of the chamber into the conduit, may be collected and withdrawn.

The bottom 24 of the chamber is provided with a slurry discharge pipe 31 which may lead into a sump 32 so that the end of the pipe lies beneath the level of the slurry in the sump. A quantity of slurry is thus continuously maintained in the pipe and air is prevented from escaping from the chamber through the pipe.

A circumferential trough 33 is mounted on the inner wall of the chamber with its upper edge somewhat above the level of the nozzle 14 and this trough has a draw-off pipe 34 which may lead into a sump similar to sump 32. Within the trough is a tubular partition member 35 mounted on rods 36 extending outward through openings in the wall of chamber 10. The rods pass through slots in the vertical wall of the trough and the arrangement is such that the tubular partition member 35 may be placed in different positions of adjustment with its top edge at different levels above the upper edge of the trough. The partition 35 flares outwardly at its lower end, as indicated at 37.

Below a trough 33 is a similar trough 38 having a discharge pipe 39 leading into a sump, and a tubular partition 40, which is similar to partition 35, is mounted within trough 38 on rods 41. The flared lower edge 37 of the partition 35 extends outwardly so as to lie above trough 38 and the partition 40 is flared at its lower end 40' so that its edge lies outward beyond nozzles 27 on head 26.

The nozzle shown in Fig. 2 includes a block 42 having a central chamber 43 into which slurry is introduced through a pipe 44, the lower end of the chamber 43 being conical and closed by a threaded member 45 provided with a discharge opening 46. Compressed air is supplied to the nozzle by a pipe 47 and enters a passage 48 leading to an annular chamber 49. From this chamber lead a plurality of discharge passages 50 formed in member 45. The member 45 has a generally conical recess 51 in its lower face and the passages 50 open through the face of that recess. The passages extend generally tangentially and direct air streams against the slurry issuing from the discharge opening 46 and cause the slurry to be broken up into minute drops which form a flat cone.

In the practice of the new method by the apparatus disclosed, a current of air is maintained through the chamber 10 by fan 26a and the slurry is atomized in the nozzle 14. The minute drops forming the mist or spray of slurry then move outwardly from the nozzle across the upwardly moving current of air. The drops containing the lightest particles pass to the wall of the chamber in the region above the trough 33 and are collected in that trough and carried away through the discharge pipe 34. The heavier particles fall through the current of air to be collected either in the lower trough 38 or in the bottom of the chamber. By regulating the velocity of the air stream, some of the lightest droplets, including those made up entirely of water or containing the slimes, may be carried out of the chamber, so that the slurry being treated may be either dewatered or deslimed or both.

The separation at different particle sizes can be controlled by varying the vertical position of the nozzle with relation to the troughs 33 and 38 and also by adjusting the position of tubular partitions 35, 40 with relation to the troughs in which they are mounted. When partition 35 is raised, its upper edge tends to intercept a certain number of the droplets which would otherwise enter trough 33, and the material impinging on the inner surface of partition 35 runs down the partition and then drips off the flared lower edge thereof into trough 38. Similar lowering of partition 35 permits droplets, which would otherwise be intercepted by the partition, to enter trough 33.

In the practice of the new method, it has been found that a good separation may be obtained and the materials collected in the different troughs show on analysis that the fraction in trough 33 contains a considerably greater proportion of fine particles than the fractions collected in the lower trough and at the bottom of the chamber. It has also been found that in the treatment of slurries having a comparatively high water content, the fraction in trough 33 will contain considerably more water than the fraction in the lower trough.

When flotation reagents are to be employed, they will be introduced into the slurry line 16 leading to nozzle 14 or into the intake of pump 17. In either case, a thorough mixing of the reagents and the slurry is obtained and the reagents are in contact with the particles for so short a time that selective coating of the particles is obtained.

As mentioned above, a mechanical atomizer may be used for discharging the slurry, instead of the compressed air atomizer shown. Such a mechanical atomizer may be of the usual type which includes a rapidly rotating disc or impeller by means of which the slurry is discharged by centrifugal action.

By the term "slurry," as used in the appended claims, we refer to a mixture of small solid particles of a size not to exceed about 90 microns, and liquid. Such a slurry varies in viscosity, depending upon its liquid content, but, as ordinarily produced and used in the cement industry, for example, it is quite thick. In a slurry, the particles are bound together by the surface tension of the liquid and the material behaves like a homogeneous fluid.

We claim:

1. A method of treating slurry, which comprises creating a current of air through an enclosed space, discharging slurry into the air current by atomizing the slurry to form a fine spray thereof, the air current causing the drops of slurry to be carried along with it for distances varying inversely with the specific gravity of the drops, and separately collecting fractions of the slurry at points spaced along the path of flow of the air.

2. A method of treating slurry which comprises creating a current of air through an enclosed space, discharging slurry into the air current across the direction of flow of the current by atomizing the slurry to form a fine spray thereof, the air current causing the drops of slurry to be carried along with it for distances varying inversely with the specific gravity of the drops, and separately collecting fractions of the slurry at points spaced along the path of flow of the air.

3. A method of treating slurry which comprises creating an upward current of air through an enclosed space, discharging slurry by atomizing it into the air current across the direction of flow of the current, the atomization forming the slurry into a fine spray and the air current causing the drops of slurry to be carried along with it for distances varying inversely with the specific gravity of the drops, and separately collecting fractions of the slurry at points spaced along the path of flow of the air, part of the fractions being collected above the level at which the atomized slurry enters the air current.

4. A method of treating slurry which comprises creating an upward current of air through an enclosed space, discharging slurry by atomizing it into the air current across the direction of flow of the current, the atomization forming the slurry into a fine spray, and collecting fractions of the slurry at points spaced along the path of flow of the air, part of said fractions being collected below and part above the level at which the atomized slurry enters the air current.

5. A method of treating slurry which comprises creating an upward current of air through an enclosed space, discharging slurry by atomizing it into the air current across the direction of flow of the current, the atomization forming the slurry into a fine spray, and collecting fractions of the slurry at points along the boundary of the space above and below the level at which the atomized slurry enters the air current.

6. A method of treating slurry which comprises creating a current of air through an enclosed space, discharging slurry into the air current by atomizing the slurry, to form a fine spray thereof, the current being of such velocity as to carry the drops of slurry along with it for distances varying inversely with the specific gravity of the drops and to carry a fraction of the slurry out of the space, and separately collecting the slurry not carried out of the space in fractions at points spaced along the path of flow of the air.

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REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
459,267	Clarkson	Sept. 8, 1891
701,827	Anderson et al.	June 10, 1902
1,212,596	Williams	Jan. 16, 1917
1,517,509	Hokanson	Dec. 2, 1924
1,595,257	Stebbins	Aug. 10, 1926
1,660,682	Stebbins	Feb. 28, 1928

FOREIGN PATENTS

Number	Country	Date
751,592	France	June 26, 1933