Jan. 5, 1932. E. ANDERSON 1,839,456

ART OF MIXING FINELY DIVIDED SOLID MATERIALS

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Fig. 1.

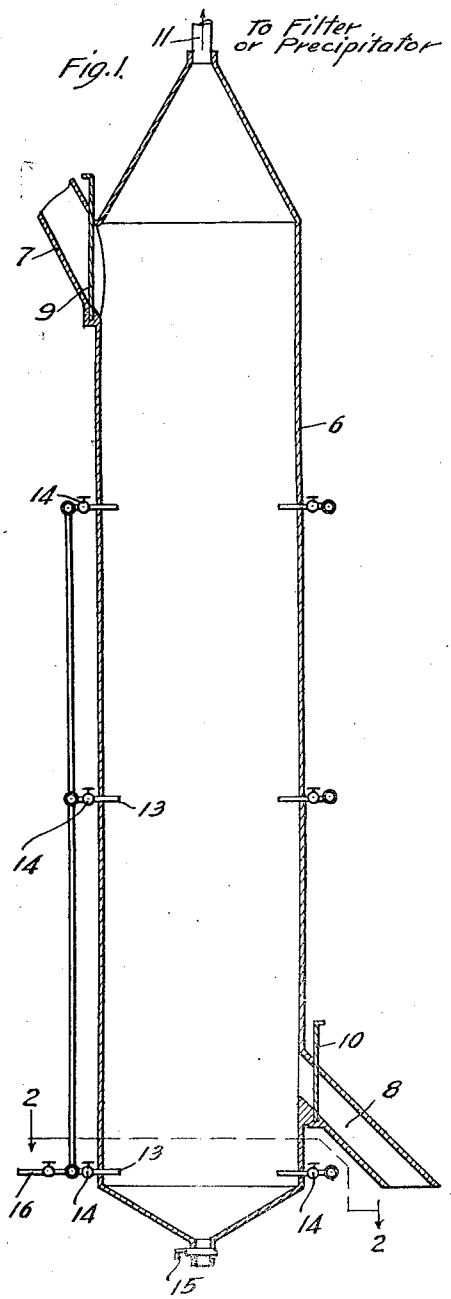


Fig. 2.

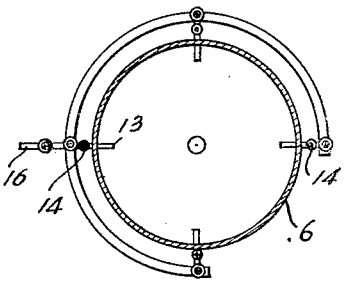


Fig. 3.

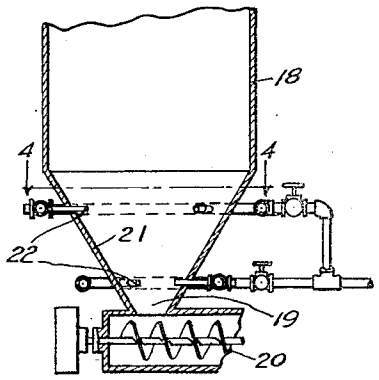
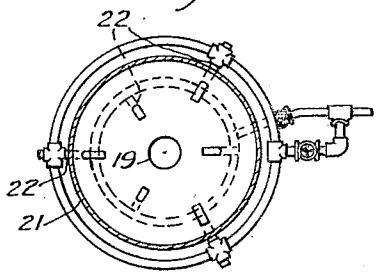


Fig. 4.



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Fig. 5.

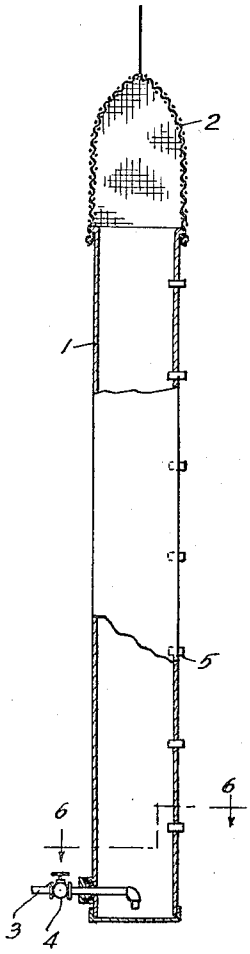


Fig. 7.

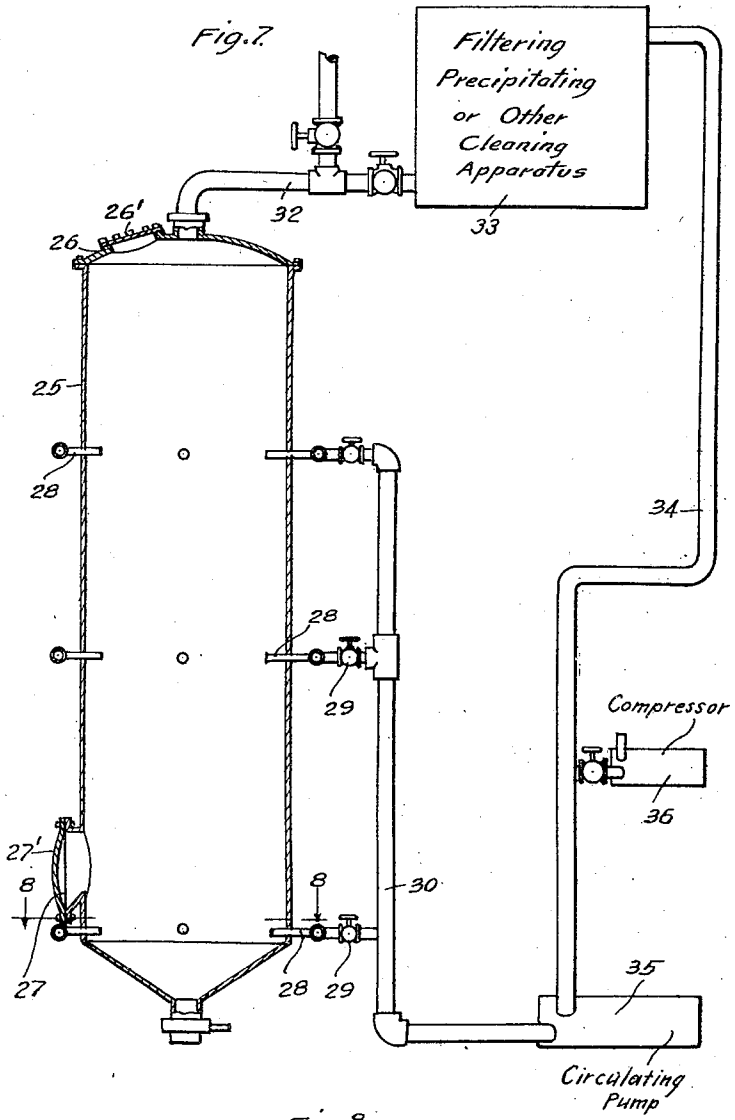


Fig. 6.

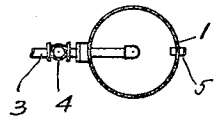
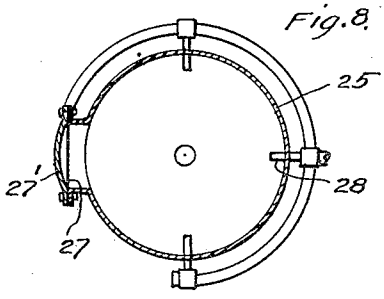


Fig. 8.



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UNITED STATES PATENT OFFICE

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ART OF MIXING FINELY DIVIDED SOLID MATERIALS

Application filed May 23, 1927. Serial No. 193,439.

This invention relates to an improved method of mixing non-homogeneous solid materials and the main object of the invention is to provide a method whereby finely divided solid materials may be mixed expeditiously, efficiently and economically in a substantially dry state. While the invention is capable of various uses, it is particularly adapted for mixing a so-called raw mix for hydraulic or Portland cement in a substantially air dry state. In the manufacture of cement by the wet process, the raw mix is produced in a condition of slurry which is stored in silos and the slurry from different silos is mixed or blended according to the indications given by analyses to produce a constant or definite analysis in the finished cement. The facility with which the wet process lends itself to accurate mixing of the raw mix has been considered an important advantage of the wet process as distinguished from the dry process of cement manufacture, since it has heretofore been impracticable to mix the dry finely ground material produced in the dry process as efficiently or economically as can be done with the wet process.

An important object of my invention is to carry on the operation of mixing non-homogeneous finely divided dry materials in such manner that a condition of mobility is maintained in the body of material being mixed, so as to obtain to a large degree the fluidity of a slurry or similar wet mixture. This object I attain by the action of air or other gas, substantially free from extraneous water, forced into contact with the dry finely divided material in such manner that all parts of the material are maintained in mobile condition. I have found that by causing air or other gas to be distributed into and upwardly through the body of finely divided material being mixed, that the material may be kept in a state of suspension in the current of air and by properly regulating the strength of the air current passing through the body of material the constituents of material of different size or density may be brought rapidly into a state of uniform mixture. I have also found that the effect of the air or other gas in suspending or rendering mobile the finely divided solid particles may be increased by increasing the pressure of the air or other gas as hereinafter set forth.

The accompanying drawings illustrate embodiments of my invention and referring thereto:

Fig. 1 is a vertical section of a mixing tower or chamber.

Fig. 2 is a horizontal section on line 2—2 in Fig. 1.

Fig. 3 is a partial vertical section showing a modification of the invention.

Fig. 4 is a section on line 4—4 in Fig. 3.

Fig. 5 is a vertical section of a simple form of apparatus for carrying out my invention.

Fig. 6 is a section on line 6—6 in Fig. 5.

Fig. 7 is a vertical section of a form of apparatus suitable for carrying out my invention under conditions of high pressure.

Fig. 8 is a section on line 8—8 in Fig. 7.

I will first describe my invention in connection with the form of apparatus shown in Figs. 5 and 6 which illustrate a construction used to test the efficiency of the dry mixing operation by means of an air current.

In these figures the chamber for containing the material to be mixed consists of a casing 1, formed for example as a vertical steel pipe closed at the bottom as indicated and open at the top, a filter member or screen 2 of suitable mesh being removably secured to the top of casing 1. Means such as a pipe 3 are provided for introducing air under pressure and free from extraneous water to the lower part of the casing 1, said pipe being provided with suitable means such as valve 4 for controlling the admission of air and being connected to any suitable source of compressed air supply at proper pressure. A plurality of openings 5 are provided at different levels in the casing 1 to permit withdrawal of material for test purposes, said openings being closed by stoppers.

In carrying out my invention in this form of apparatus the non-homogeneous material to be mixed, consisting for example of two portions of finely ground Portland cement raw mix from different batches, or any other two finely ground materials, such as raw mix

and limestone, or shale and limestone, are placed in the casing 1, in a state of normal dryness, and without addition of extraneous water, the filter 2 is then secured in position over the top of casing 1 and air under suitable pressure is then turned on through pipe 3 into the casing at the lower portion thereof so that a current of dry air is caused to pass upwardly through and in contact with the finely divided material. In this particular instance the mixing chamber is of relatively small cross-sectional area in proportion to its height, being for example 6 inches in diameter and 12 feet high, so that substantially uniform distribution of the air current throughout the body of material may be effected with a single air inlet as shown. After the air blast at a pressure of about 10 pounds per square inch has been maintained for a period of 60 minutes it is found that a substantially complete mixture of the material is secured through out the height of the height of the column of material in the casing except for the portions immediately adjacent the air inlet.

The following table shows the result of a test made with finely divided limestone and clay, each ground to about 95% or over through 200 mesh. The heavier material (limestone) was placed in the bottom part of the chamber 1 and the clay on top of it, and after one hour's run the mixture was substantially complete, as shown by the table, except for the lowermost section. The percentages of limestone as given in the table represent results of analysis on material withdrawn through the openings 5, at the time intervals stated at the head of each column.

Height above bottom	Material put in at start	Percent CaO			
		Start	½ hour	1 hour	1½ hours
0	Limestone	41.0	33.2	33.0	31.9
1 foot	Limestone	40.6	34.6	21.4	18.5
2 feet	Limestone	40.5	21.5	20.1	19.6
3 feet	Clay	6.34	18.4	19.9	19.8
4 feet	Clay	5.10	18.9	19.9	19.2
5 feet	Clay	0.23	17.9	19.9	19.2
6 feet	Clay	0.23	17.5	20.6	19.9

In applying my invention on a commercial scale I may advantageously use the construction shown in Figs. 1 and 2 in which the casing 6, formed for example as a vertical cylinder or silo of steel or other suitable material, is provided with a feed chute 7 at its upper end and a discharge chute 8 at its lower end, said chutes being provided with gates 9 and 10 for controlling the passage of material. The upper end of the casing 6 is provided with an outlet 11 leading to a filter, precipitator or other means for removing or collecting the dust blown out of the material being mixed by the operation of the gas current. In order to effectively distribute the air or gas under pressure into the interior of the casing 6, a plurality of nozzles or outlets 13 are preferably provided, distributed in different angular positions around the casing and also at different levels so as to introduce air into different portions of the material being mixed as may be required, valves 14 being provided for control of the supply of air through each nozzle or each set of nozzles. The bottom of the casing 6 may be provided with a discharge gate 15 for emptying or cleaning out the same when required, the normal discharge being however through the discharge passage 8 which is somewhat above the bottom of the casing for the reasons hereinafter set forth.

In carrying out my invention in this apparatus the non-homogeneous material is charged into the casing 1, said material consisting of two or more different components introduced into the supply chute 7 from different sources and passing into the casing 6 either simultaneously or successively and being either not mixed at all or being in a state of very imperfect mixture. Such materials may consist, for example, of material from different batches of Portland cement raw mix, which it is desired to blend to give a correct mixture. If desired the gates 9 and 10 may be closed during the blowing operation. The compressed air or other gas under pressure, supplied from a compressor or other suitable source passes through supply pipe 16 and the several nozzles 13 into the body of material in casing 6. In practice the column of material in the casing 6 will generally be of quite considerable height, say of 20 feet or more, so that it is desirable to first admit air or gas through the upper nozzles or tuyères 13 where the pressures of the material is at a minimum and then when the upper part of the column has been levitated or rendered light and open by the action of the air or gas thus introduced the next lower series of the nozzles may be opened so as to admit air or gas at a lower level, and finally air or gas is admitted through the lowermost nozzles, the upper nozzles being closed so that the air or gas which is introduced has to pass through the entire column of material. If it is attempted to introduce air in the first place only at the lower part of the column of material the pressure required will generally be excessive and far beyond that which is necessary to maintain the inflow of air or gas when the operation is under way and the whole body of material has been brought to a condition of mobile suspension in the ascending current of air. Thus I have found that the pressure required to introduce the air at the bottom of a column of cement raw mix material 20 feet high may be as much as 60 pounds per square inch as compared with a pressure of about 25 pounds per square inch required for maintaining the inflow after the ascending current of air has been established.

By maintaining the current of air for a sufficient time, depending on the character of the materials being mixed a substantially complete mixture of materials may be obtained, and such mixture may be effected in a relatively short time and at minimum expense and it is possible in this manner to produce blending of cement raw mix batches as efficiently with dry mix as with slurry mix. In some cases the mixture effected at the extreme lower portion of the column may be incomplete and for this reason it is desirable to discharge the mixture from the column at a point somewhat above the bottom, the discharge chute 8 being suitably located for that purpose. When the mixture is complete the discharge gate 10 is opened and a new batch of material charged into the mixing chamber and the operation repeated. Any dust that is carried out of the body of material by the current of air may be collected in any suitable filter or precipitator means and returned to the mixing chamber or otherwise disposed of.

It is evident that when the amount of material carried away by the air current is practically negligible, or when the material carried away is collected and returned directly to the mixing chamber as above described, substantially all the solid constituents of the body of material are retained therein throughout the mixing operation. After the thorough mixing of the entire batch of material is thus completed, such material is removed from the mixing chamber as above described.

As shown in Figs. 3 and 4 the casing or mixing chamber 18 may be provided with a discharge outlet 19 at its bottom, delivering the material to a suitable conveyor 20, the lower end of the casing 18 being formed as a cone 21 and the air or gas nozzles 22 opening into the cone portion of the chamber, the construction and operation being otherwise as above described.

In the embodiments of my invention above described the air or gas is necessarily introduced into the column of material under pressure sufficient to enable it to force its way through the material and this pressure will generally be considerable, particularly in the lower portions of the column even where the upper end of the column is substantially at atmospheric pressure. In some cases I may provide for maintaining a condition of relatively high pressure on the entire column of material in order to take advantage of the property of air or gas under pressure of rendering dry finely divided solid material mobile or fluid. The apparatus shown in Figs. 1 to 4 may be adapted to such an operation by suitably controlling the efflux of gases from the mixing chamber. I have shown however in Figs. 7 and 8 a form of apparatus particularly suitable for maintaining a relatively high pressure on the entire column of material, such apparatus comprising a casing 25 provided with a supply opening or man-hole 26, and discharge opening 27 said openings being normally closed by gas tight closures 26′ and 27′. The air or gas nozzles 28 are connected through valves 29 to supply pipe 30 leading from a suitable source of compressed gas. Where pressures in excess of, say, 100 pounds per square inch are used it is desirable to recirculate the air or gas so as to reduce the cost of compression and for this purpose the outlet 31 for the mixing chamber may lead through a valve 32 to a filtering, precipitating or other cleaning apparatus 33 from which a pipe 34 leads to a circulating pump 35 for returning the gas to the inlet pipe 30. The entire system may be maintained under suitable high pressure by means of a compressor 36 pumping atmospheric air or other gas into the pipe 34 or other part of the circulating system. The operation of my invention in this apparatus is similar to that above described with the additional effect due to the high pressure of the air or gas tending to produce a state of mobility or fluidity in the body of finely divided dry material, this effect being added to the mobility or relative fluidity produced by the ascending air current.

While the materials being mixed are referred to herein as being "substantially dry" or in a state of normal dryness, this does not imply that the same should be perfectly free from water, but merely that no additional water need be added thereto before or during the mixing operation. The materials to be mixed may naturally contain varying proportions of water, as in the case of raw materials for Portland cement manufacture, and such materials fall within the terms above mentioned, as used herein. Furthermore, while the air or gas used for mixing is described as being substantially dry and the operation is described as being carried out in the absence of extraneous water, it is of course not necessary that such air or gas be absolutely dry. Ordinary atmospheric air, or other gas, containing varying amounts of water vapor, may be used, the above mentioned expressions signifying only that no water is added to the air or gas, or otherwise introduced into the materials being mixed.

Claims:

1. The method of mixing heterogeneous finely divided solid materials in a dry state which comprises introducing said materials into a closed chamber, injecting gas under pressure into said materials successively at a plurality of points of different elevation beginning at the highest of said points, maintaining the injection of said gas from the lowermost of said points until said materials are well mixed and removing said materials

from said chamber at a point adjacent the bottom thereof.

2. The method of mixing finely divided solid materials in a dry state which comprises introducing said materials into a closed chamber and injecting gas under pressure into said materials while progressively increasing the depth of material above the level at which the gas is injected, then maintaining the injection of said gas until said materials are well mixed and removing said materials from said chamber at a point adjacent the bottom thereof.

3. The method of mixing finely divided solid materials in a dry state which comprises introducing said materials into a closed chamber and injecting gas under pressure into a shallow body of the materials, progressively altering the relation between the body of materials and the point of injection of the gas to inject the gas under a body of materials of progressively greater depth, maintaining the injection of gas until the materials are well mixed and then removing said materials from said chamber at a point adjacent the bottom thereof.

In testimony whereof I have hereunto subscribed my name this 16th day of May, 1927.

EVALD ANDERSON.