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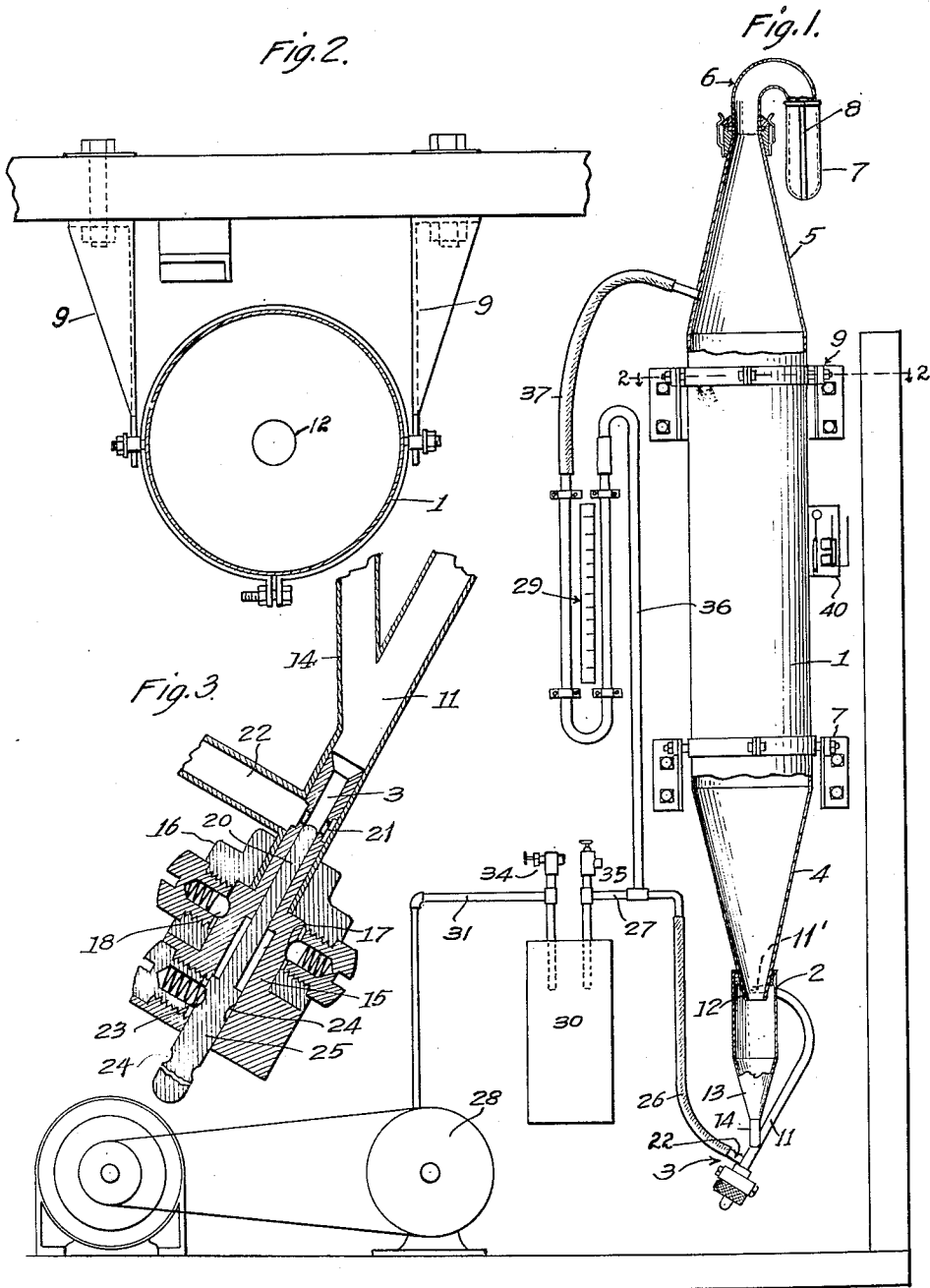
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1,894,623

ELUTRIATING MEANS

Filed March 7, 1929

2 Sheets-Sheet 1



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Fig. 4.

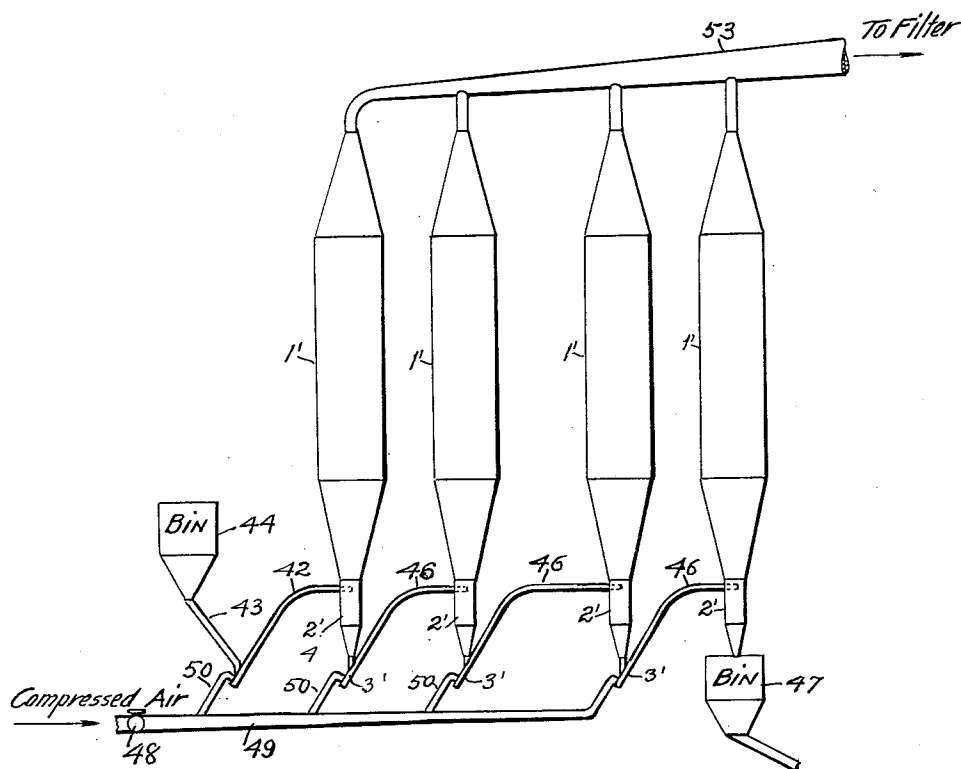
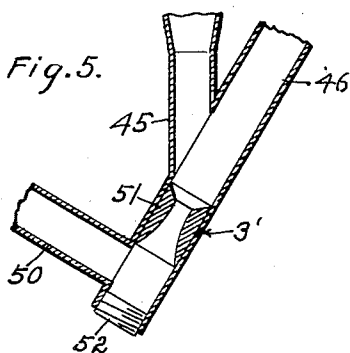


Fig. 5.



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UNITED STATES PATENT OFFICE

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ELUTRIATING MEANS

Application filed March 7, 1929. Serial No. 344,997.

This invention relates to a means for separating finely divided materials from coarser materials and is applicable either as a flour meter or means for determining the percentage of such finer materials in an aggregate or as a means for cleaning divided materials by removing so-called fines or flour therefrom or for any other purpose for which an elutriator is suitable.

One object of the invention is to provide for performing the separating operation referred to by the action of air thereby dispensing with the use of a liquid with its attendant inconveniences.

A further object of the invention is to provide an elutriator operation which will be closely selective and at the same time more rapid than the usual devices using liquid as a separating medium.

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

Fig. 1 is a side elevation of the apparatus partly in section.

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

Fig. 3 is an enlarged section of the ejector nozzle used in connection with the separating apparatus.

Fig. 4 is a side elevation of an embodiment of the invention adapted for continuous operation.

Fig. 5 is a section of the nozzle means adapted for use with the construction shown in Fig. 4.

I will first describe my invention as applied to the determination of fines or flour in a body of divided material, for example, ground cement. The determination of the percentage of flour is important as a control of grinding operations. With heretofore available methods, this determination requires so much time that its usefulness in controlling grinding operations is greatly impaired. The improved flourometer disclosed herein is particularly useful to control the grinding of cement clinker. It is well known that in cement, the particles larger than say 350 mesh, although representing a large portion of the original weight have very little covering power and are prac-

tically useless in binding the aggregate together. Even if these particles harden, their contribution to the finished concrete is nearly the same as that of grains of sand of equal size. The improved flourometer disclosed herein can be adjusted to show almost at a glance what fraction of the sample of cement is active in binding aggregate together.

The embodiment of my invention shown in Figs. 1 to 3 comprises elutriator means 1, in which size segregation is effected by a rising current of air; cyclone means 2 wherein the larger particles are actively subjected to the washing action of an air current and gradually washed clean of all adhering fine particles and separated therefrom, and nozzle means 3 delivering gas to the cyclone and elutriator means for operation thereof.

The elutriator means 1 may consist of a vertical cylinder or chamber having a tapering inlet portion 4 at its lower end, communicating with the cyclone means 2 through opening 12 which forms the central outlet for said cyclone means, and a tapering outlet portion 5 at the upper end of cylinder 1 connected through a thimble holder 6 to a filter thimble 7 which may be removably attached thereto by means (such as a rubber band 8) and is adapted to receive the fines or flour. The member 1 may be mounted on any suitable support, for example, brackets 9.

Cyclone means 2 may consist of a vertical cylinder or chamber, surrounding and secured (preferably removably) to the inlet means 4 for the elutriator, said inlet means 4 extending down into the cylinder 2 a sufficient distance to form the outlet means for the cyclone.

Nozzle 3 is provided with an outlet pipe 11 leading to an inlet 11' opening tangentially into cyclone cylinder 2, and said cyclone cylinder is formed with a tapering lower end 13 communicating by vertical tube 14 with the pipe 11, said pipe 11 being preferably inclined upward at an acute angle and the nozzle 3 being in line with pipe 11, and below the point of entry of tube 14 thereinto. Nozzle 3 is preferably mounted on pipe 11 by

means of a head 15 on the nozzle fitting in socket means 16 on pipe 11, and having recesses 17 engaged by spring catches 18 in said socket means, normally holding the nozzle means in position within tube 11, but enabling its forcible removal when it is desired to withdraw the contents of the pipe 11, which serves as the receptacle for the material to be tested. It is also desirable to provide means for closing the nozzle 3 when it is to be withdrawn, and for this purpose a pin or plug 20 may be slidably mounted in the nozzle passage, so as to be moved forward to close the same or to be moved back to position shown in Fig. 3 to open the nozzle, which is provided with lateral apertures 21 communicating with the nozzle passage and with an air supply pipe 22, said apertures being exposed when the means 20 is drawn back.

A spring catch 23 on nozzle head 15 engages recesses 24 in a shank 25 of closure means 20 to hold the closure means either in position to close the nozzle or in position to open the nozzle, said shank also serving as a handle for operating the closure means.

Air supply pipe 22 is connected to means for supplying air at a definite pressure, said pipe being for example connected by a flexible tube 26 to a pipe 27, in connection with a pump or compressor 28 and with a manometer 29. A tank 30 may be connected between the pipe 31 leading from the pump 28 and the pipe 27, to receive any lubricating oil that might be carried over from the pump, and the connections between the pump and the inlet pipe of the nozzle are also provided with a regulating needle valve 34 opening to the outer air to allow a certain fraction of the available air stream to escape and capable of close adjustment to determine with the desired uniformity, the pressure existing at the inlet of the nozzle, and with a by pass valve 35 also opening to the outer air and enabling the pressure on the nozzle 3 to be quickly reduced to a small fraction of the operating value and then quickly restored to this operating value.

Manometer 29 is connected by pipe 36 to air supply pipe 27 and by pipe 37 to the elutriator chamber 1 so as to indicate the effective pressure head of the nozzle.

A rapping device, such as an electromagnetic vibrator indicated at 40 may be provided for jarring the elutriator and the parts connected thereto, to prevent the flour from adhering to the side walls of the apparatus.

Before introducing the sample, the pressure on nozzle 3 is read on manometer 29 and regulated by means of the needle valve 34. A convenient size sample (25 grams) is weighed. The pressure is quickly reduced by means of by pass valve 35 and the sample is introduced through a small funnel at opening 6. The thimble holder is replaced over the opening. By pass valve 35 is closed to

impress the desired pressure upon nozzle 3, and the rapping device started. Nozzle 3 creates a suction in pipe 14 leading from the cyclone and this suction draws the sample into pipe 11 where it is subjected to a vigorous washing action by the air jet from nozzle 3 the operation of said air jet resulting in a current of gas which passes upwardly through pipe 11 into the cyclone chamber 2 and then downwardly through the cyclone chamber to the pipe 14, so that such gas is circulated repeatedly through the cyclone chamber. The material tested is discharged tangentially through opening 11' into the body of the cyclone 2, and is thus subjected to further agitation and also to a centrifugal separating action, so that the heavier particles are thrown out and collected at the bottom of chamber 2 and then again sucked into pipe 11 to be again subjected to the washing action of the air jet. This is repeated again and again. It will be understood that, due to the suction created by the nozzle, a certain portion of the air will be drawn from chamber 2 back into pipe 11, and part of the air will therefore be repeatedly circulated through the cyclone chamber, assisting in delivery of the solid material from chamber 2 into pipe 11. Meanwhile a volume of air equal to the volume of air introduced at nozzle 3 escapes through the opening 12 into the bottom of the elutriator chamber 1, carrying the fine flour as well as some heavier particles. These heavy particles cannot rise with the air current in elutriator chamber 1 on account of the low upward velocity of air therein (the chamber 1 being of much larger cross-sectional area than the gas conducting means 11) and therefore fall back into the cone 4 and slide along its walls until they pass again through opening 12 into cyclone chamber 2. The lighter particles are carried by the air stream through the elutriator chamber 1 and deposited in thimble 7. At regular intervals thimble 7 is changed. When this is to be done, the pressure is suddenly decreased by opening valve 35, when the thimble is changed and valve 35 closed. The collection in thimble 7 is shaken out and weighed. When the total thimble collection is plotted against time the resultant curve gives a very accurate check upon the progression of the analysis. Such a check is obtained without appreciable interruption of the test, thus greatly accelerating the test. When the test is completed, nozzle assembly 3 is removed and the residue withdrawn from the apparatus by means of gentle tapping. The residue is accurately weighed to determine the results of the analysis, as the thimble collection is chiefly used as a check upon the progress of the analysis.

A series of consecutive tests upon the same sample of cement, using a $\frac{1}{8}$ inch nozzle, with

an air pressure of 5 inches of mercury, gave as residue values of 52.16%, 53.00% and 52.48%, for 20 minute runs. A microscope slide was exposed to the stream of dust at the outlet of the elutriator at the end of one run and gave a tentative calibration of 18.3 microns as the separation size. A series of four consecutive tests made with a smaller nozzle. (No. 42 drill), the same air pressure but 25 minute runs, gave values for the residue of 64.2%, 63.88%, 64.04% and 63.60%.

My invention may also be used for cleaning or classification of divided substance, for example, granular, powdered or ground ore or rock. For this purpose it is desirable to provide for continuous operation, and the apparatus illustrated in Figs. 4 and 5 is suitable therefor. Said apparatus may comprise a series or plurality of units each including an elutriator chamber 1', an agitating cyclone chamber 2' at the lower end of the elutriator chamber and nozzle means 3' connected to deliver the divided material by air current to the cyclone device. The construction of these devices may be similar to that of the devices shown in Figs. 1 to 3, it being understood, however, that for the purpose of commercial treatment of large quantities of granular material, the said devices will be of suitable size to give the requisite capacity. The finely divided or granular material to be cleaned or classified is delivered to the air or gas inlet pipe 42 of the cyclone chamber of the first unit, by suitable means, for example, by chute or pipe 43 leading from a bin 44. The material collection outlet 45 at the bottom of each cyclone 1', discharges into the nozzle outlet pipe 46 of the next following unit, so as to be carried forward with the air current passing to the cyclone of such next unit. the outlet 45 for the last unit discharging into suitable receiving means, such as a bin 47. Air or gas under a suitable pressure, regulated if desired by a valve 48, is supplied through pipe 49 connected by pipes 50 to the respective nozzles 3'. Said nozzles may be constructed as shown in Fig. 5, with an orifice or nozzle means 51 adapted to provide a regulated or definite volumetric rate of flow under definite pressure head, the material being delivered from the outlet 45 to the pipe 46 between the nozzle means and the inlet of the cyclone means of the next unit. A removable plug 52 may be provided for pipe 46 below the nozzle means to permit cleaning of the pipe and nozzle when desired. All the elutriator means 1' may be connected at their upper ends to a common outlet flue 53 leading, for example, to filter means or other means for disposing of the dust or flour removed from the material being treated.

The collection of the first cyclone is sucked

in at the second nozzle, subjected to the washing action of the air jet and fed tangentially into the second cyclone, some of the fines escaping through the second elutriator. This is repeated as many times as seems advisable to remove the desired portion of fines, the final residue being returned to the mill for further grinding, while the separated fines are sent into a collecting system, if it is desired to recover same.

I claim:

1. Means for elutriating divided materials comprising nozzle means, means for supplying gas under definite pressure to said nozzle means, a cyclone chamber, a pipe for conducting gas from said nozzle means to said cyclone chamber, said pipe opening tangentially into said chamber, so as to provide for cyclonic action therein, in such manner as to separate finer material from the coarser material contained therein, an elutriator chamber connected to receive a current of gas carrying divided material from said cyclone chamber and adapted to permit the coarser material to be separated by gravitative settling from the gas current, said elutriator chamber being provided at its upper portion with outlet means for discharge of gas therefrom, and at its lower end with an outlet for returning such coarser materials to the cyclone chamber and means for returning the coarser material from the bottom of the cyclone chamber to said nozzle means.

2. An elutriating apparatus comprising a cyclone chamber having a material delivering outlet at its lower end, tangential inlet means at its side, and central gas outlet means at its upper end, means for conducting gas at high velocity and reduced pressure past said material delivering outlet to draw material therethrough, said gas conducting means communicating with said tangential inlet means, and a vertical settling chamber, of much larger cross-sectional area than said gas conducting means, communicating with said central gas outlet means and extending upwardly therefrom.

In testimony whereof I have hereunto subscribed my name this 27th day of February, 1929.

MARCEL A. LISSMAN.