J. C. PEARSON.

PROCESS AND APPARATUS FOR SEPARATING AND ANALYZING GRANULAR MATERIAL.

APPLICATION FILED APR. 26, 1916.

1,186,525. Patented June 6, 1916.

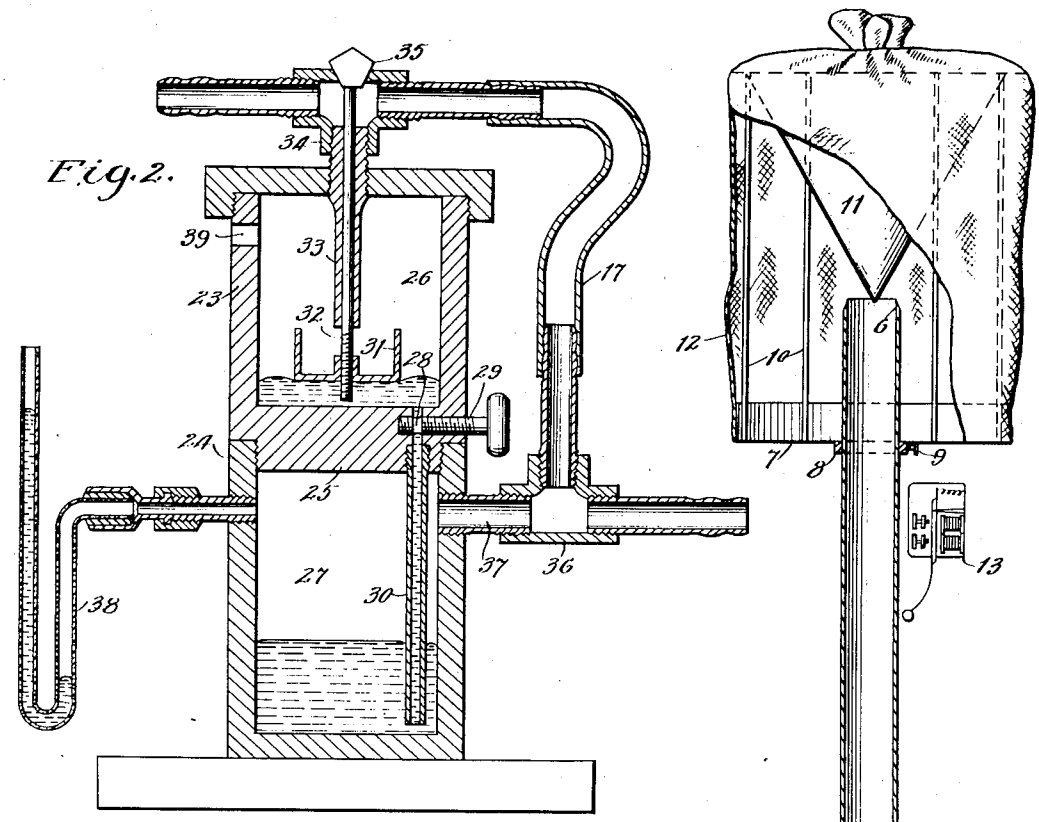


Fig. 2.

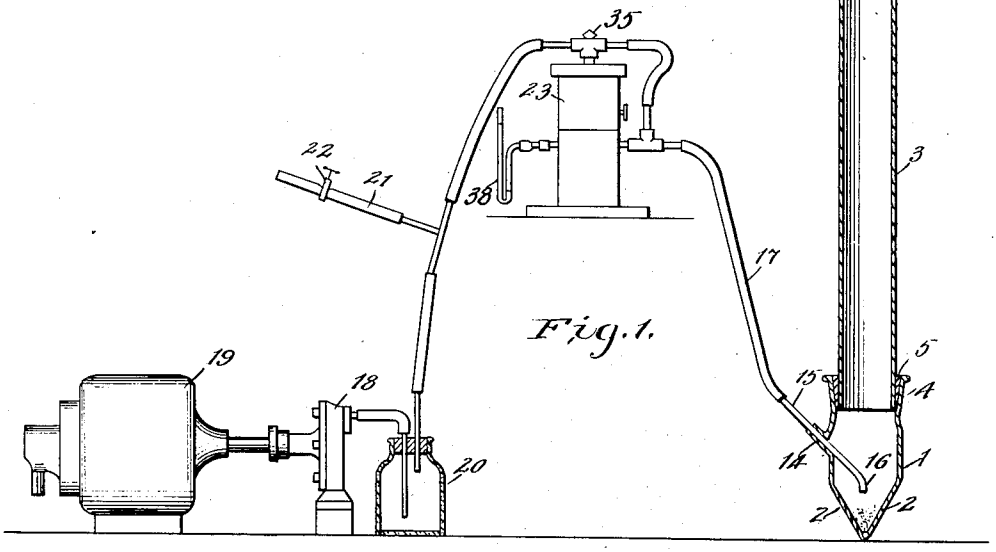


Fig. 1.

Inventor:
Joseph C. Pearson

UNITED STATES PATENT OFFICE.

JOSEPH C. PEARSON, OF CHEVY CHASE, MARYLAND.

PROCESS AND APPARATUS FOR SEPARATING AND ANALYZING GRANULAR MATERIAL.

1,186,525. Specification of Letters Patent. Patented June 6, 1916.

Application filed April 26, 1916. Serial No. 93,812.

(DEDICATED TO THE PUBLIC.)

To all whom it may concern:

Be it known that I, JOSEPH C. PEARSON, a citizen of the United States, residing at Chevy Chase, in the State of Maryland, have invented a new and useful Process and Apparatus for Separating and Analyzing Granular Material, of which the following is a specification.

This application is made under the act of March 3, 1883, chapter 143, (22 Stat., 625,) and the invention herein described and claimed may be used by the Government of the United States, or any of its officers or employees in the prosecution of work for the United States, or by any person in the United States, without the payment of any royalty thereon.

My invention relates to a process and apparatus by which granular or pulverulent material may be subjected to fluid currents to thoroughly and accurately separate the same according to the sizes or masses of the component particles; and the objects of the invention are to provide an apparatus and process by which the separation of particles below particular size or mass limits may be thoroughly and efficiently attained; to provide an apparatus in which the fluid currents may be accurately regulated, and in which lodgment of particles on the walls or other undesired portions of the apparatus may be obviated; and finally to provide a process and apparatus by which the components of a granular mass may be efficiently and substantially completely separated according to predetermined size or mass limits and the quantitative proportions of grains within the predetermined size or mass limits may be accurately determined.

I attain the objects mentioned above by the apparatus illustrated in the accompanying drawings in which—

Figure 1 is an elevation, partly in section, of the complete apparatus; and Fig. 2 is a detail view in vertical section of the fluid pressure regulator employed as an element of the apparatus.

In the drawing, in which the same reference characters designate corresponding parts in each figure, 1 designates a receptacle or bulb to contain the material to be treated; the lower portion of this bulb or receptacle is tapered or coned downwardly to an apex which may be more or less flattened or rounded, the converging portions 2 being inclined at an angle to the horizontal exceeding the angle of repose of the material being treated, this angle of inclination ordinarily being between 60 and 70 degrees from the horizontal. Said receptacle or bulb 1 preferably is cylindrical above the tapering portion, and at its top has an opening or neck of a diameter not less than that of the widest portion of the chamber of the bulb or receptacle 1, said opening or neck adapting the receptacle or bulb for detachable connection with the stack 3, which in the preferred embodiment is a vertical cylindrical tube of considerable vertical dimension, and which may be formed of metal with a polished interior surface which will present no retarding or material collecting obstructions. In the embodiment shown the neck portion 4 has a slight upward flare to adapt it to fit closely around the lower end of the stack, a thin packing ring 5 of rubber or other suitable material being interposed between the neck portion 4 and the stack if desired, in order to insure an air-tight fit. However, it is obvious that other forms of connection may be employed.

The upper edge 6 of the stack is preferably brought to a knife edge, with the outer portion sloping downwardly and outwardly, to reduce to a minimum any tendency of material to lodge thereon. On the upper portion of the stack 3 is adjustably mounted a pan 7 having a sliding collar 8 in close fitting relation to the stack and a threaded bolt 9 by means of which the pan may be vertically adjusted on the stack for a purpose which presently will appear. Said pan 7 is of a diameter considerably in excess of that of the stack, and to its outer portion are attached vertically extending rods 10, preferably eight in number, which at their tops are attached to and support an inverted 60° cone 11, which is concentrically disposed with respect to the stack 3, into which the apex of the cone projects slightly, forming an annular exit between said cone and the wall of the stack, which may be regulated by the vertical adjustment of the pan 7 and the cone 11 carried thereby. This regulation or adjustment of the annular exit gives control of the velocity at which the fluid and material suspended thereby pass through and from the stack, which velocity may be

accelerated at the point of exit. The framework formed by the rods 10 is inclosed by a fabric 12, such as canton flannel, attached at the bottom to the periphery of the pan 7, and gathered at the top to form a dust collecting bag which filters the suspended material from the fluid passing therethrough.

Adjacent and in operative relation to the stack 3 is mounted an electric tapper 13, of ordinary construction, which is adapted to agitate or impart tremulous movement to the stack 3 to dislodge any material tending to adhere to the wall thereof; the movement imparted by the tapper is transmitted to the receptacle or bulb 1 supported by the stack and aids in the circulation or agitation of the material in said bulb or receptacle and assists in the suspension of the fine particles by the impinging fluid currents.

In the side of the bulb or receptacle 1 is formed a neck 14 having a downwardly and inwardly inclined opening in which may be inserted in close fitting relation a fluid supply tube 15 having a relatively small bore, detachable to permit substitution of other tubes having different bores. This tube projects to the axial center of the bulb or receptacle and is there deflected downwardly to form a nozzle 16 directed toward the apex of the bulb or receptacle and terminating a short distance above said apex. The outer end of this tube is detachably connected to a fluid supply tube 17 extending from a blower or other suitable means for supplying fluid under pressure, a blower 18 driven by a suitable electric motor 19 being employed in the preferred embodiment. I have shown in connection with the fluid supply tube a trap 20, a blow-off 21 controlled by a valve 22, and an automatic pressure regulator 23, shown in detail in Fig. 2. As shown this regulator consists of a receptacle subdivided by a horizontal partition 25 into an upper chamber 26 and a lower chamber 27, this partition having a passage 28 establishing communication between the two chambers and controlled by a valve 29. A tube 30 is inserted in this passage and depends into proximity with the bottom of the chamber 27. In the upper chamber 26 is placed a float 31 which is vertically adjustably mounted, as by screw threading on a vertically extending spindle 32 which extends through a sleeve 33 attached to a valve fitting 34 interposed in the fluid supply tube or conduit 17. Said valve fitting is substantially a T-connection provided with a valve seat in its upper portion which opens to the atmosphere and in which operates a plug 35 formed on the top of the spindle 32, said plug preferably being of conical form. Beyond the valve fitting described the fluid supply conduit has interposed therein a T connection 36, one branch of which communicates through a nipple 37 with the lower chamber 27. This chamber 27 has connected thereto a pressure gage 38, preferably one employing a mercury column; while the upper chamber 26 communicates through a port 39 with the atmosphere. In operation, liquid, for example mercury, in quantity regulated according to the pressure it is desired to maintain, is placed in the lower chamber 27. The pressure in the fluid conduit beyond the regulator is communicated to the chamber 27 and forces more or less of the liquid therein up through the tube 30 and passage 28, which liquid accumulates in chamber 26 and lifts the float 31 and therewith the spindle 32 and plug 35, which opens the valve and permits escape of the excess fluid, thus lowering the pressure in the conduit until it reaches the degree for which the regulator may be adjusted, the liquid in the upper compartment 26 returning to the lower compartment as the pressure is reduced until a point of equilibrium is reached at which just sufficient fluid is permitted to escape to maintain the pressure at the stage desired in the nozzle tube 14. Normally the valve will be maintained slightly open by the moderate excess of pressure which is provided for by appropriate adjustment of the blower 18 and the blow-off valve 22, this excess pressure being intended also to compensate for the loss of fluid through the sleeve 33 which is in sufficiently loose relation to the spindle 32 to permit the latter to slide in the sleeve with practically no friction. The fluid conduit or tube 17 may be and preferably is formed of sections, some of which may be flexible tubing, for example rubber.

The valve 29 affords a means for retaining the regulator adjustment. When operation is suspended or interrupted said valve may be closed and the liquid which has been forced into the upper chamber of the regulator may be retained there, so that on resuming operation the valve may be reopened and the desired pressure will be very quickly restored.

The operation of the apparatus will now be described in connection with the quantitative granular air analysis of cement or similar material, but it should be understood that my invention is not limited to such particular use, for it is obvious that other gases than air may be used, and that liquids such as oils, water, etc., may be employed, especially where the material being treated will not be affected chemically or otherwise by contact with such liquids. Further, it is obvious that the process and apparatus may be employed for other than the analysis of granular materials, for example, for the production of powdered material of desired grain sizes, for the separation of material according to specific grav-

ity, and other like uses; and that various changes in sizes of parts, manner of delivering material to the separating chamber, removing residues therefrom, collecting the material removed by the fluid, and variations and omissions in the process steps, will naturally suggest themselves to those skilled in the art. Therefore I do not wish to be limited to details described herein except as expressly stated in the claims, and intend to include in the scope of my invention all proper equivalents.

In the quantitative granular air analysis of cements, I have found a stack length of 150 cm. (60 inches), with an internal diameter of 6.8 cm. (2.7 inches,) a bulb having an apex 14 cm. (5.5 inches) below the bottom of the stack, and nozzles having bores approximating 1 mm., 2 mm. and 3 mm. inch respectively where a four fraction separation of cement passing a 200 mesh sieve is desired, to be very efficient, an air pressure approximating 1 pound per square inch being employed.

The motor and blower may be started at slow speed and the nozzle to be employed connected to the air conduit. This causes a rise in pressure in the lower compartment 27 of the regulator which is indicated on the gage 38, the pressure being further regulated by gradually closing the blow off valve 22, the speed of the motor and blower being increased if the pressure does not reach the desired limit when the valve 22 is entirely closed. Having attained the desired pressure, the valve 29 is closed and the nozzle is removed from the fluid conduit or tube and inserted in the bulb which is detached from the stack. A sample of cement, ordinarily 33⅓ grams if .001 inch grains are to be separated, and 50 grams if coarser is placed in the bulb. The bulb is then reconnected to the stack and the nozzle tube to the air tube or conduit, the valve 29 being then reopened. The tapper 13 is then started and the separation permitted to proceed. The nozzle is maintained in such relation to the apex of the bulb that with the fluid pressure employed and the agitation due to the tapper the whole mass of material in the bulb is maintained in continual agitation, constantly presenting different portions to the impact of the air blast, this impact and the attrition due to the motion of the material detaching the particles which adhere. The fine particles become suspended in the air current which is deflected upwardly, expands and then passes with substantially uniform stream lines through the stack, through the annular exit and through the dust collector which separates the fine particles from the air. The substantially uniform current limits the size of the particles which will be carried out, those exceeding the desired size either dropping back into the bulb or remaining within the region of the stack. The operation is maintained until substantially all of the desired fine particles have been removed; in practice it has been ascertained that the operation is substantially complete when a rate of loss of .02 gram per minute is reached. The approximate time of separation is ascertainable with a little experience, and this being known, 15 or 20 minutes before the estimated time, the fluid conduit is disconnected from the nozzle and a short period, ½ minute or more is allowed for the particles in the stack to settle back into the bulb; the bulb and its contents are removed and weighed, after which the bulb and nozzle are reconnected with the stack and fluid conduit respectively and the operation resumed for a period of say 10 minutes, when they are again removed after another cutting off of the fluid supply and short interval of rest and reweighed. If the observed loss of weight is greater than .2 gram the separation is repeated for another ten minutes, and so on until a loss not exceeding .2 gram is observed when the operation may be regarded as completed. From the previously ascertained weights of bulb and sample, the weight of sample, and the final weight of bulb and residue the amount removed and its percentage relation to the sample may readily be calculated. If it be then desired to separate a coarser grade or fraction a nozzle with a larger bore may then be substituted and the operation repeated. In practice I have found the time for the operation on a sample of cement for one fraction ordinarily will be from 1 to 2 hours.

I claim:

1. The process of separating granular material consisting in subjecting a confined body of such material to mechanical agitation and a downwardly directed fluid current regulated to maintain the whole mass in movement, deflecting and expanding the current with its suspended contents and causing the same to travel upwardly with uniform flow, and separately collecting the portions separated.

2. The process of separating granular material consisting in subjecting a confined body of such material to mechanical agitation and a downwardly directed gaseous current adapted to maintain the whole mass of material in movement, deflecting and expanding the current with its contents, causing the same to travel upwardly with uniform flow and separately collecting the portions separated.

3. The process of quantitatively separating granular material consisting in subjecting a predetermined mass thereof in a confined region to a downwardly directed fluid current regulated to maintain the mass in

motion, deflecting and expanding the current with its contents, causing the same to travel vertically upwardly with uniform unobstructed flow removing the suspended particles uniformly peripherally from the region of vertical flow, maintaining the action until the mass is free from particles below a predetermined size, and finally determining the proportion removed by the fluid current.

4. The process of quantitatively separating granular material consisting in subjecting a predetermined mass thereof within a confined region to a gaseous current regulated to maintain the mass in motion, deflecting and expanding the current with its suspended contents, causing the same to travel vertically upwardly with uniform unrestricted flow from the region of mass confinement, removing the suspended material uniformly peripherally from the upper end of the region of vertical flow, maintaining the action until the mass is free from particles below a predetermined size, and finally determining the portion removed by the gaseous current.

5. The process of quantitatively separating granular material consisting in subjecting a predetermined mass thereof within a confined region to mechanical agitation and a downwardly directed fluid current adapted to maintain the mass in motion, deflecting and expanding the current with its suspended material, causing the same to travel vertically upwardly with uniform unobstructed flow from the region of confinement, maintaining the action until the mass is free from particles below a predetermined size, and finally determining the proportion thereby removed.

6. The process of quantitatively separating granular material consisting in subjecting a predetermined mass thereof within a confined region to mechanical agitation and a vertically downwardly directed gaseous current adapted to maintain the mass in motion, deflecting and expanding the current with its suspended material, causing the same to travel vertically upwardly with uniform unobstructed flow from the region of confinement, maintaining the action of the gaseous current until the mass is free of particles below a predetermined size and finally determining the proportion removed by the current.

7. In combination, an open topped material receptacle, an elongated vertical unobstructed conduit co-extensive in horizontal section with the receptacle, connected thereto in vertical alinement and having a top discharge extending throughout the periphery of said conduit, a vertically downwardly projecting nozzle intermediate the walls of the receptacle and extending into proximity to the bottom of said receptacle, means for delivering fluid through the nozzle, and means for imparting agitation to the receptacle.

8. In combination, an open topped material receptacle, an elongated vertical unobstructed conduit co-extensive in horizontal section with the receptacle and connected thereto in vertical alinement, said conduit having a top discharge extending throughout the upper periphery of the conduit, a vertically downwardly projecting nozzle intermediate the walls of the receptacle extending into proximity with the bottom thereof, means for delivering fluid under regulated pressure through the nozzle, and means for imparting agitation to the receptacle.

9. In combination, an open topped material receptacle, an elongated unobstructed conduit co-extensive in horizontal section with the receptacle, connected thereto in vertical alinement, having a discharge at its top extending throughout the conduit periphery, said conduit being free from projections upon which material may lodge, a vertically downwardly projecting nozzle intermediate the walls of the receptacle and extending into proximity with the bottom of said receptacle, means for delivering fluid through the nozzle, and means for imparting agitation to the conduit.

10. In combination an open topped material receptacle, an elongated vertical unobstructed conduit co-extensive in horizontal section with the receptacle, connected thereto in vertical alinement, having a discharge at its top extending throughout the conduit periphery, said conduit being free from projections upon which material may lodge, a downwardly projecting nozzle intermediate the walls of the receptacle extending nearly to the bottom thereof, means for delivering fluid regulated in force through the nozzle, and means for imparting agitation to the conduit.

11. In combination, a material recptacle, an elongated vertical unobstructed impervious conduit connected to the top of said receptacle in vertical alinement therewith, said conduit being free from obstructions upon which material may lodge, means for projecting fluid downwardly through the material in the receptacle and upwardly through the conduit, and means for imparting vibration to the conduit.

12. In combination, a material receptacle, an elongated vertical unobstructed impervious conduit connected to the top of said receptacle in vertical alinement therewith, said conduit being free from retaining parts upon which material may lodge, means for projecting fluid downwardly against the material in the receptacle and upwardly through the conduit, and means for imparting vibrations to the conduit and receptacle.

13. In combination, a material receptacle,

an elongated vertical unobstructed impervious conduit connected to the top of the receptacle in vertical alinement therewith, said conduit being free from retaining parts upon which material may lodge, means for projecting fluid downwardly against the material in the receptacle and upwardly through the conduit, means for regulating the force of the fluid, and means for imparting vibration to the conduit.

14. In combination, a material receptacle, an elongated vertical unobstructed impervious conduit connected to the top of the receptacle in vertical alinement therewith, said conduit being free from retaining parts upon which material may lodge, means for projecting fluid downwardly against the material in the receptacle and upwardly through the conduit, and means for imparting vibration to the receptacle and conduit.

15. In combination, a material receptacle, an elongated vertical unobstructed impervious conduit connected to the top of the receptacle in vertical alinement therewith, said conduit being free from retaining parts upon which material may lodge, means for projecting fluid downwardly against the material in the receptacle and upwardly through the conduit, means for regulating the force of the fluid, and means for imparting vibration to the receptacle and conduit.

16. In combination, an open topped receptacle for material, an elongated vertical unobstructed conduit co-extensive in horizontal section with the receptacle and connected thereto in vertical alinement, said conduit being free from retaining parts upon which material may lodge, means for projecting fluid downwardly against the material in the receptacle and upwardly through the conduit, and means for agitating the receptacle and conduit.

17. In combination, an open topped material receptacle, an elongated vertical unobstructed conduit co-extensive in horizontal section with the receptacle and connected thereto in vertical alinement, said conduit being free from retaining parts upon which material may lodge, means for projecting fluid downwardly against the material in the receptacle and upwardly through the conduit, means for regulating the force of the fluid, and means for agitating the conduit and receptacle.

JOSEPH C. PEARSON.