

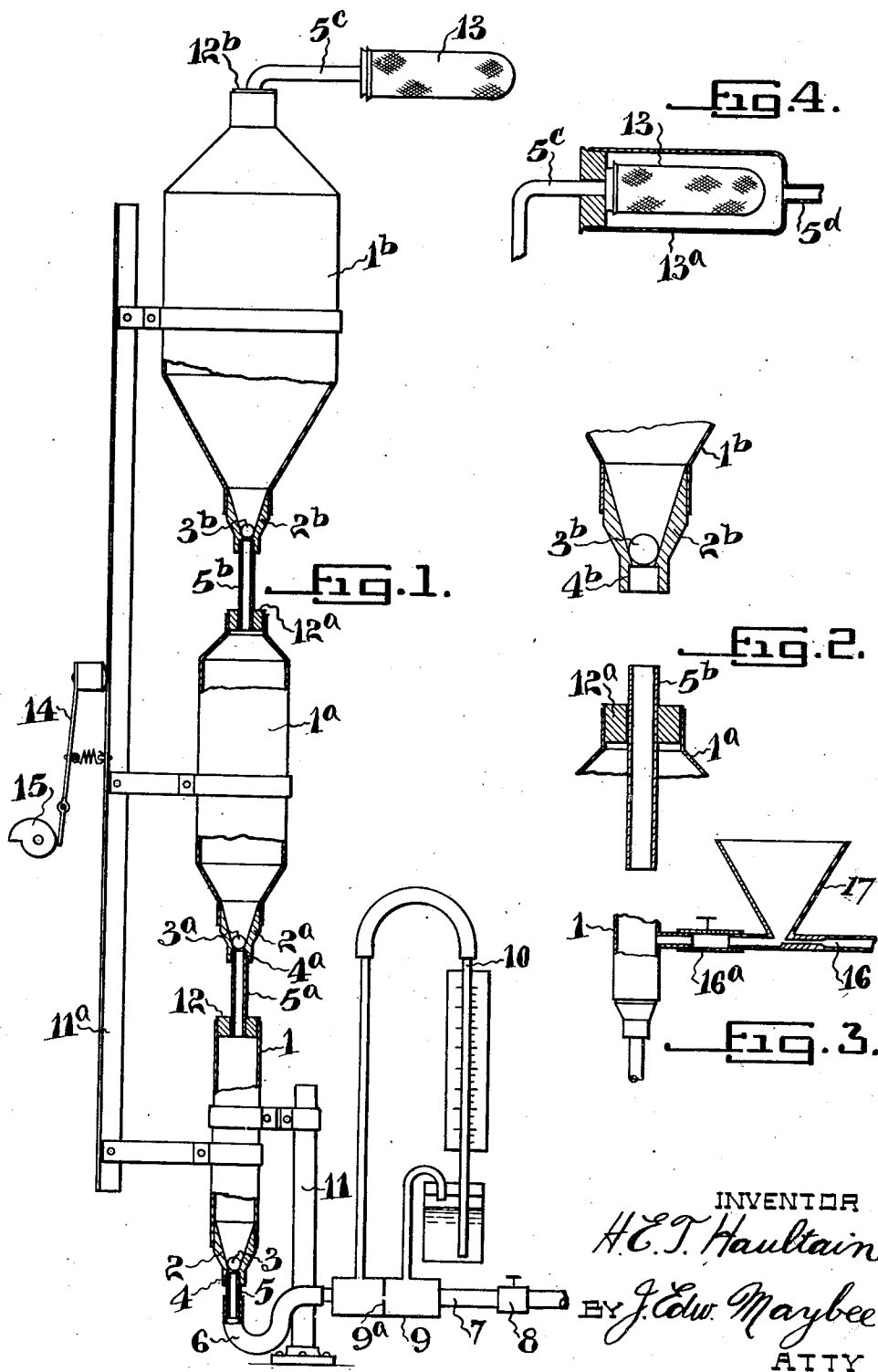
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APPARATUS FOR ANALYZING FINELY DIVIDED MATERIALS FOR SIZE

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APPARATUS FOR ANALYZING FINELY
DIVIDED MATERIALS FOR SIZE

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This invention relates to apparatus for obtaining a separation or a size analysis of the particles in a finely divided product by subjecting it to fluid currents through a tube or a series of tubes of different diameters so that different sized particles will be separated. The object of the present invention is to devise simple means for causing a complete breaking up of agglomerated particles so that an accurate separation of the product will be obtained during each test.

I attain my object by providing the tube or each tube with an inlet in which a normally closed valve member is carried so that as the continuous current of air or other fluid is passed through each inlet its valve member is opened. Finely divided solids suspended in the air may thus flow past the valve member which is adapted not only to prevent back flow of the solids from its tube but to assist in the breaking up of agglomerated particles so that a continuous current of air or other fluid through the tube will carry the smaller particles therefrom. By connecting in series a number of tubes of progressively greater diameter the said means prevents backflow of solids from one tube to its preceding tube in addition to its other function and the current of fluid carries the different sized particles to the different sized tubes in the series in one operation. The tubes are arranged in spaced relationship and are so connected that the contents of each may be readily removed without disturbing the tubes.

The constructions are hereinafter more fully described and are illustrated in the accompanying drawing in which:

Fig. 1 is a diagrammatic view of my apparatus showing three tubes connected in series;

Fig. 2 a detail in vertical section through the adjacent ends of two tubes showing the connection therebetween in its disconnected position;

Fig. 3 a diagrammatic view of a receptacle connected with my apparatus; and

Fig. 4 a diagrammatic view of the thimble housing used when suction means is employed.

In the drawing like numerals of reference indicate corresponding parts in the different figures.

1 is a tube which may serve as a receptacle for receiving the finely divided material to be analyzed. The bottom end of the tube is provided with a substantially conical inlet 2 having a ball 3 seated therein. The lower end of the inlet 2 is counterbored at 4 to receive one end of a piece of tubing 5 the other end of which is connected by means of flexible tubing 6 with any suitable type of fluid supply means such as a compressed air line 7. To regulate the flow of air passing through the tube 1, I provide a valve 8 in the line 7 and any suitable flow meter

such as the diaphragm gauge 9 and manometer 10 which indicates the difference in pressure on opposite sides of the diaphragm 9^a.

The tube 1 is carried on a standard 11 and supports a frame 11^a which carries one or more tubes 1^a, 1^b which are connected in series as hereinafter described. The tube 1^a is larger in diameter than the tube 1 and the tube 1^b is larger in diameter than the tube 1^a so that the velocity of the fluid passing through the tubes is progressively decreased whereby different sized particles will be deposited in the different sized tubes. The tubes 1^a, 1^b are provided with tapered ends and with conical inlets 2^a, 2^b having balls 3^a, 3^b seated therein and the lower ends of these inlets are counterbored at 4^a, 4^b to receive pieces of tubing 5^a, 5^b. To the outlet end of tube 1 is fitted a rubber stopper 12 in which the tubing 5^a is slidable so that it may be moved axially towards or away from the counterbore 4^a in the inlet 2^a of the tube 1^a to permit it to be disconnected therefrom. If desired, the lowered tubing and the stopper may then be lifted from the outlet end of the tube 1. Similarly the outlet ends of the tubes 1^a, 1^b are provided with stoppers 12^a, 12^b, the tubing 5^b being slidable in the stopper 12^a to permit it to be disconnected from the counterbore 4^b in the inlet 2^b of the tube 1^b. In the stopper 12^b a piece of bent tubing 5^c carrying a porous thimble 13 may be inserted. This thimble is adapted to filter the solid particles or fractions from the air which escape through the pores of the thimble.

If it be desired to draw the air through the tubes 1, 1^a and 1^b, the thimble 13 may be dispensed with and in this case the tubing 5^c will be connected with any suitable suction means such as an aspirator or injector (not shown). When suction is employed the preferred arrangement is to mount the thimble 13 in a housing 13^a having an outlet 5^d for connection with the suction means.

Each of the tubes may be vibrated individually or a spring actuated hammer 14 adapted to strike the frame 11^a may be used to vibrate all the tubes simultaneously. This hammer may be controlled by a motor driven cam 15 so that the tubes and also the balls 3, 3^a and 3^b will be continuously vibrated during each test.

Assuming a sample of the finely divided product, which may be cement, has been placed in the tube 1, the valve 8 opened to obtain the desired flow of air and the hammer mechanism started, the operation is as follows. The air passing through the tubing 5 forces the ball 3 off its seat in the inlet 2 and passes through the product in the tube 1 thus carrying the small sized particles or fractions with it. These particles which are of various sizes are thus suspended

in the air and pass with the air through the tubing 5^a to force the ball 3^a off its seat in the inlet 2^a of the tube 1^a. As the tube 1^a is larger in diameter than the tube 1, the velocity of the air with the fractions suspended therein is decreased during the passage of the air through the tube 1^a and the heavier particles carried by the air remain in the tube 1^a. The air and the particles still in suspension pass through the tubing 5^b and the heavier of these particles remain in the tube 1^b. The lightest particles are carried with the air through the tubing 5^c and deposited in the thimble 13. The air is continuously supplied to the tube 1 and the hammer 14 is continuously vibrating the tubes for a predetermined period of time so that the particles of different sizes will be completely separated.

This separation is facilitated by the action of the valve member 3, which may be a ball or a plug of any suitable shape and weight, a steel ball has been found satisfactory. The ball is continuously vibrated not only by the current of air and particles passing through the inlet but by the motion imparted thereto by the vibration of each tube. The ball is thus moved longitudinally and laterally in the inlet and thus through the entering flow of particles which causes the separation of very fine particles from one another and from coarser particles. Any flocks of fine particles and the coarser particles with fine particles adhering thereto, which have a tendency to adhere to the side of the tube, are shaken therefrom by the vibration thereof and fall back on to the ball, slide down its surface and come under the action of the high velocity air as it passes irregularly around the sides of the ball or under the action of the ball as it strikes its seat. This results in the particles in the lower end of each tube being moved or circulated in a spray fashion around the lower end of the tube. In other words, the air in blowing through the product above the ball, thoroughly agitates the particles so that they are more or less in agitated suspension in the lower part of the tube. Those particles whose settling rate is less than the upward travel of the air in the middle portion of the tube pass on to the next tube. Many particles are adhering together and thus act as large particles which, as hereinbefore described, fall down the sides of the tube and are then blown upwardly again. Thus in each tube there are a number of particles continually rubbing against one another and thus freeing themselves of attached particles. The operation is continued until the particles have been separated from one another and the undersized particles have been blown out of each tube.

Of course, it will be distinctly understood that any desired number of tubes may be used and that the greater the number in use the greater the number of different sized particles will be separated. That is to say the number of tubes used in a test will of course be determined by the number of separations required of the product being tested. It is obvious that the tubing 5^c with its thimble 13 may be connected with the tube 1 or 1^a, and that any number of tubes may be used between the tube 1^b and the tubing 5^c.

When the particles have been thoroughly separated, the hammer 14 is stopped and the valve 8 closed. After sufficient time for the particles to settle has elapsed, the thimble 13 is removed and the quantity of the contents determined so that the proportion of this size of particle can be

determined. The contents of each of the tubes 1, 1^a, 1^b are removed therefrom by axially moving the tubings 5, 5^a, and 5^b through the stoppers 12, 12^a and 12^b away from the counterbores 4, 4^a, 5^b so that receptacles may be positioned beneath the latter. By passing a suitable tool such as a stiff piece of wire through a counterbore and the lower end of the inlet, the ball therein will be forced upwardly so that the particles in the tube will fall by gravity into the receptacle beneath the tube. The quantity of particles from each tube may then be determined in the same manner as those from the thimble.

From this description it will be noted that the product is separated into the desired number of fractions in one operation and that the fractions may be readily removed from each of the tubes without disconnecting the latter from the frame.

If desired, the tube 1 may be connected with a receptacle 17 having an air line 16 across the bottom thereof for feeding the product to the tube. Any suitable valve or pinch cock may be used to close the portion 16^a of the line 16 to prevent the air from within the tubing 6 escaping through the receptacle after the contents thereof have been blown into the tube.

What I claim as my invention is:

1. Apparatus of the class described comprising a plurality of settling tubes connected in series; means for passing finely divided solids suspended in a fluid through the series of tubes, the tubes being of progressively greater diameter from the tube adjacent the fluid entering end of the series towards the tube at the fluid outlet end, the tubes having valve seats at their inlet ends; and valve members adapted to engage the seats to prevent backflow of solids from the tubes and adapted to be raised off the seats by the passage of the fluid therethrough.

2. Apparatus of the class described comprising a plurality of settling tubes connected in series; means for passing finely divided solids suspended in a fluid through the series of tubes, the tubes being of progressively greater diameter from the tube adjacent the fluid entering end of the series towards the tube at the fluid outlet end; substantially conical inlets in the fluid entering ends of the tubes; and valve members adapted to be seated in the inlets to prevent backflow of solids from the tubes and adapted to be shifted longitudinally of the inlets by the passage of the fluid therethrough.

3. Apparatus of the class described comprising a plurality of settling tubes carried in spaced relationship to one another, each tube having an outlet and an inlet; tubing slidably fitted in the outlet of each tube adapted, when extended, for connection with the adjacent inlet of the next tube; means for passing finely divided solids suspended in a fluid through the tubes; and means in each inlet for preventing backflow of solids therethrough.

4. Apparatus of the class described comprising a plurality of settling tubes carried in spaced relationship to one another, each tube having an outlet and an inlet; tubing slidably fitted in the outlet of each tube adapted, when extended, for connection with the adjacent inlet of the next tube; means for passing finely divided solids suspended in a fluid through the tubes; and a ball seated in each inlet for preventing backflow of solids therethrough.