

July 26, 1938.

R. K. ROURKE

2,125,086

PNEUMATIC CLASSIFIER

Filed Jan. 29, 1935

2 Sheets-Sheet 1

Fig. 1.

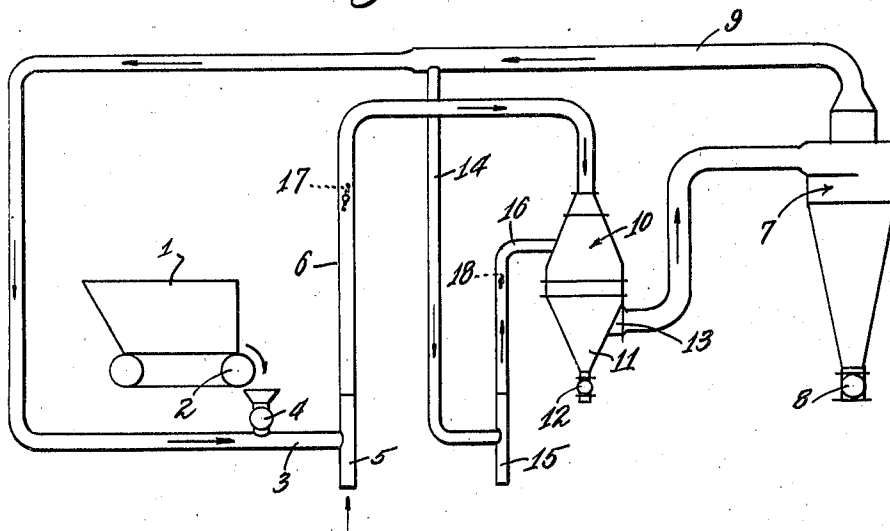


Fig. 5.

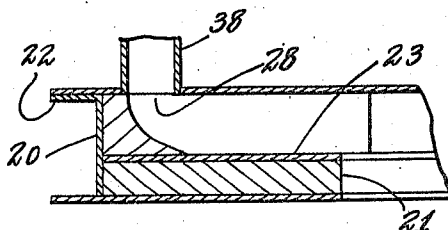
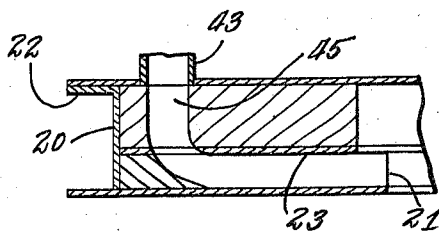


Fig. 6.



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Fig. 2.

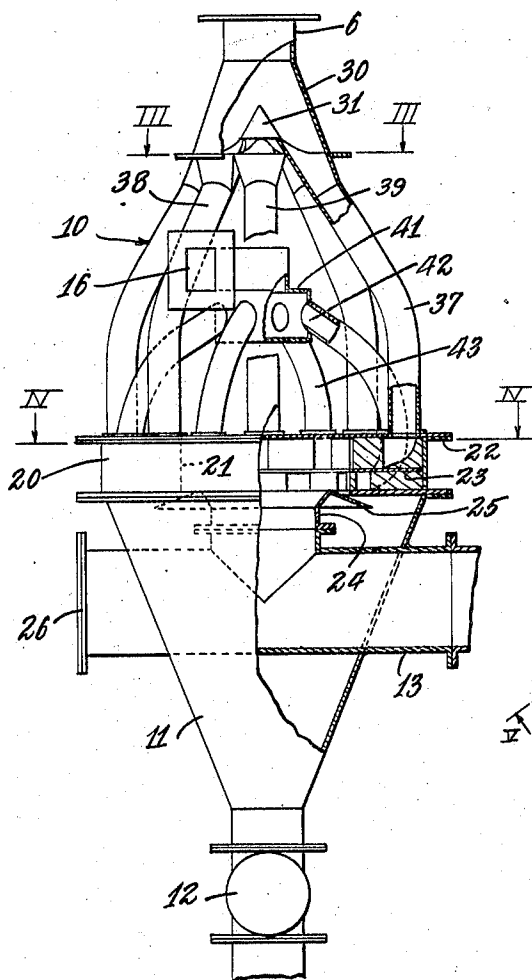


Fig. 3.

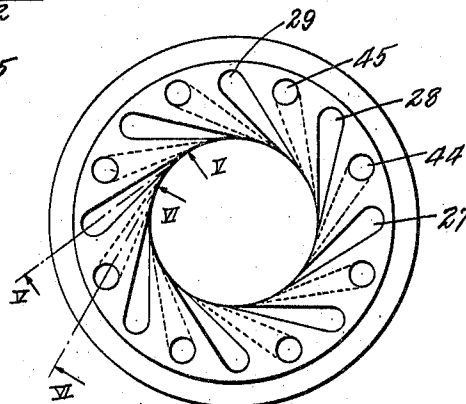
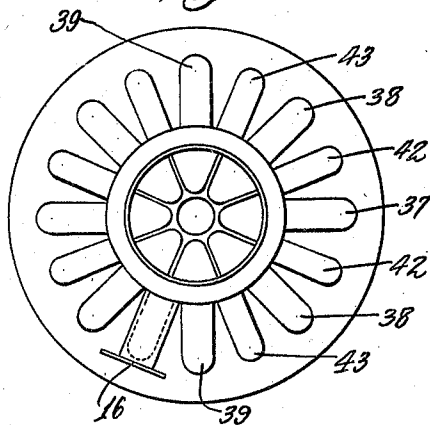


Fig. 4.

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UNITED STATES PATENT OFFICE

2,125,086

PNEUMATIC CLASSIFIER

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10 Claims. (Cl. 209—144)

This invention relates to methods and means whereby disintegrated, pulverulent or comminuted materials such as the non-metallic minerals, clays, decolorizing carbons, etc., may be treated for the removal of impurities and/or particles which are larger than or heavier than remaining portions of such disintegrated material.

In the manufacture of disintegrated or comminuted materials such as diatomaceous filter-aids (in natural uncalcined form and/or in calcined or chemically treated form), bleaching clays or decolorizing material and numerous other substances used in a finely divided condition, it is highly desirable to remove impurities.

The reasons for such removal need not be explained in detail but it may be stated for purposes of illustration that in the manufacture of diatomaceous filter-aids the removal of coarse particles is desirable as such coarse particles do not function as effective components of the filter-aid. Very often the impurities, although within the desired particle size (by linear or volumetric measurement), are of a higher specific gravity than the main body of material and such heavy particles should also be removed.

In prior methods of classification, separators of the cyclone type have been extensively used but in such separators there is a tendency for the finer particles to adhere to larger particles and to be carried with such larger or coarse particles out of the system whereas it is highly desirable that such finer particles be removed from the coarse, thereby increasing the output of the more finely divided product. In the normal and usual separators of the cyclone type, only a minor proportion of the material introduced (generally less than 20%) is separately discharged as fines, whereas the method of this invention contemplates the separation of the finer particles from the same feed material to the extent of 40% or more of the total feed.

The method of this invention distinguishes from prior methods in that a fluid bearing a heterogeneous mixture of large and small particles in suspension is continuously introduced into a classification or separation zone and a body of such fluid rotating in a substantially horizontal plane is formed. Fluid bearing the smaller and lighter particles is continuously withdrawn axially from the central and lower portions of such body of fluid. The fluid introduced into the classification zone is introduced at a velocity sufficient to impart a decided outward velocity component to the larger and heavier particles, which particles assume a downwardly inclined, spiral path toward the outer and lower portions of the classification and separation zone. In order to more effectively separate the lighter, and smaller particles from the larger particles, additional or secondary fluid is tan-

gentially introduced into the lower portion of the classification and separation zone and in the direction of rotation of the aforesaid body of fluid. This secondary fluid may be preferably introduced at substantially the same velocity as the primary fluid bearing the disintegrated material in suspension although higher or lower velocities can be used. The secondary fluid also assists in separating smaller particles from adherent contact with larger particles and/or associated with larger particles in the outer portions of the classification zone, moving such lighter particles toward the center of such zone.

Furthermore, the second fluid is preferably substantially free from disintegrated material. Such secondary air is, moreover, introduced at a plurality of circumferentially spaced points so that the larger and heavier particles are repeatedly subjected to blasts of incoming and secondary fluid which opposes the outward component to some extent and blows adhering fine particles from the larger and heavier particles. Eventually, the now cleansed larger and heavier particles of material are separately discharged from points along the lower edge of the classification or separation zone.

It is to be noted that in the usual cyclone type of separator, the fines are removed upwardly (against the action of gravity) while the coarser particles move downwardly. In the method and apparatus of this invention, both fines and coarse move downwardly but along different paths, the separation thereby taking place without relying upon gravity to the extent characterizing prior methods.

Although the method of this invention may be carried out in various forms of apparatus, the present invention is also directed to a preferred form and arrangement whereby the method of this invention may be carried out very effectively. The invention also contemplates a combined milling and classification system in which the hereinabove described method may form an integral part.

It is an object of this invention, therefore, to disclose and provide a method of classifying disintegrated, comminuted and/or pulverulent materials.

Another object is to disclose and provide a method of classifying and/or separating disintegrated materials for the purpose of removing therefrom larger and heavier particles.

A further object of the invention is to disclose and provide a combined milling and classification system in which the classification of disintegrated, non-metallic minerals and the like may be most effectively performed.

A still further object of this invention is to disclose and provide an arrangement of means whereby the classification and separation of dis-

integrated materials may be rapidly, economically and accurately obtained.

These and other objects, uses and advantages of the invention will become apparent to those skilled in the art from the following detailed description of a milling system, classification means and classifying method of operation. It is to be understood that the subsequently described specific forms and conditions of operation are simply illustrative and numerous changes, modifications and adaptations of this invention will be readily apparent to those skilled in the art.

In describing the invention, reference will be had to the appended drawings, in which

Fig. 1 diagrammatically represents a combined milling, classifying and separating system.

Fig. 2 is a side elevation, partly in vertical section, of the preferred form of classifier.

Fig. 3 is a plan view of the classifier illustrated in Fig. 2.

Fig. 4 is a horizontal section taken along the plane IV—IV of Fig. 2.

Fig. 5 is a vertical section taken along the plane V—V of Fig. 4.

Fig. 6 is a vertical section taken along the plane VI—VI of Fig. 4.

In Fig. 1, the feeder bin is represented at 1, this bin containing disintegrated material supplied thereto from a preliminary or primary milling system, not shown. The material from the bin 1 may be discharged in controlled quantities by means of an automatic feeder 2 into the inlet line 3 of the system through a rotary seal mechanism 4. The gases passing through the line 3 are picked up by a blower, such as a paddle type fan 5, and discharged through a line or conduit 6 into the outer end of a classifying unit 10. In this unit (subsequently described in greater detail) the disintegrated material is classified, the larger and heavier particles being retained within the lower housing 11 for discharge through the valved outlet 12 whereas the smaller and lighter particles are discharged through the conduit 13. The conduit 13 leads to a separator 7 in which the particles are more or less perfectly separated from the conveying fluid or gas, the particles settling in the lower portion of the separator from which they may be removed through the valved outlet 8, whereas the gas or fluid is discharged through conduit 9.

When operating under substantially closed circuit conditions, the outlet conduit 9 may connect with the inlet conduit 3, as indicated. Furthermore, the discharge conduit 9 may be provided with a branch line 14 leading to a fan or blower 15 which then supplies secondary air or gas to the classifier 10 through the line 16. Dampers may be provided in the conduits 6 and 16' as indicated at 17 and 18 respectively.

Although in the above described form of apparatus air is constantly recirculated, it is obvious that the blower 5 may draw in atmospheric air or gas from any suitable source, such as for example, preheated gas or air. The discharge line 9 may furthermore be connected with a bag house or other suitable separating device for the removal of finest particles therefrom. The blower 15 preferably supplies a gas or fluid to the classifier 10 which is substantially free from disintegrated material and may well draw in atmospheric air instead of the air or gas discharged by the separator 7.

As has been stated hereinbefore, the classifier 10 functions for the removal of larger and heavier

particles from the suspension of disintegrated material supplied thereto by the feed conduit 6. This feed will hereinafter be referred to as the primary feed and for purposes of illustration it will be assumed that air is the medium used in conveying the disintegrated material through the apparatus.

The classifier, more specifically shown in Figs. 2 to 6 inclusive, consists of a classifier 20 which, internally, is substantially cylindrical with substantially cylindrical walls. The interior of such classification zone is indicated at 21. Such classification zone is provided with a closure member or cover plate 22 and may well be divided into an upper and lower section, said sections being separated by a plate or member 23. In the preferred embodiment shown in the drawings the height of the classifier (the distance from the closure plate 22 to the lower edge of section 20) does not exceed the internal diameter of the classifier. The lower portion of the classifier 10 is enclosed by a housing, such as the inverted cone 11. Mounted within the housing is a funnel-like member 24 with its upper edge extending slightly above the bottom edge of the classifier 20 and spaced from the walls thereof. The edge of the funnel member 24 is provided with an outwardly and downwardly extending apron 25 directed toward the housing 11, said apron 25 being spaced from the lower edges of the interior surface 21 of the classifier. The funnel member 24 communicates with the discharge line 13 which may extend through the housing 11, one end of the line 13 being sealed as by plate 26.

The diameter of the upper edge of the funnel member 24 bears an important relation to the inside diameter of the classifier, i. e., the diameter of wall 21. The diameter of the classifier should not be more than twice the diameter of the upper edge of the funnel and preferably the ratio should be about 4:3 or 7:5. The funnel may even have a diameter equal to the inside diameter of the classifier, the upper edge of the funnel member, under such conditions, being placed slightly below the lower edges of the surface 21 of the classifier. It is to be understood that the diameter of the classifier at the secondary inlet portion may exceed the diameter of the primary air inlet portion, although the form shown is more readily constructed.

The upper portion of the classifier 20, that is, the portion between the closure member 22 and the horizontally disposed partition plate 23, may be provided with a plurality of tangentially directed passageways indicated at 27, 28, 29, etc. By identifying the passageways 27, 28, 29, etc., as tangential, it is to be understood that they may be tangential to the inner wall 21, or to the outlet funnel 24, or to some circle between these two elements. These passageways preferably terminate in openings which are larger in height than in width and which become reduced in cross sectional area as they approach the inner wall 21 of the classifier, thereby causing an increase in the velocity of gases passed therethrough. The shape of these openings is not critical and may be varied greatly, nor is it necessary that the passageways vary in cross sectional area.

The closure member 22 is provided with a plurality of ports communicating with such passageways. Conduits, such as the conduits 37, 38 and 39, connect the ports in the closure plate 22 with a conical head 30 connected with the intake conduit 6. Axially positioned within the cone 30 is a distributor cone 31 which assists in

insuring an equal distribution of gases to the various downwardly directed conduits 37, 38, 39, etc. In this manner it will be seen that the aeriform suspension of disintegrated material supplied to the classifier 10 by the intake conduit 6 is distributed through the conduits 37, 38, 39, etc., to the tangentially directed passageways 27, 28, 29, etc.

A vortex is thus formed within the classifier 10, the only outlet therefrom being through the funnel-like member 24 and discharge line 13. The port of the funnel-like member 24 is located in a plane not materially below the edge of the section 20 and preferably in a plane virtually coincidental with the plane of the lower edges of the secondary air inlet ports. Outwardly directed components are thus caused to exist in a direction opposite to the inwardly directed components due to the movement and discharge of gases from such vortex. The tangential or outwardly directed component will vary with the velocity of the fluid discharged into the classification zone; the radial, inwardly directed component will vary with the volume of fluid supplied. When the volume of air used is maintained constant, the tangential velocity may be increased or decreased by changing the area of the inlet ports, and it may be noted that an increase of velocity will decrease the average particle size of the product discharged as fines.

As a result, the lighter and smaller particles pass with the gas through the funnel-like member 24 into the discharge line 13 while the larger and heavier particles tend to move toward the inner wall 21 of the classifier zone 20, along which wall they move helically downward.

In order to classify the disintegrated material with extraordinary accuracy, secondary air is admitted through the conduit 16 into a manifold 41 from whence it is distributed by a plurality of conduits, such as the conduits 42, 43, etc., through suitably arranged ports in the cover plate 22 to passageways or channels 44, 45, and the like, formed in the lower portion of the classifier zone 20. These passageways 44, 45, etc., discharge tangentially into the classifier at a plurality of circumferentially spaced points. The velocity of the gases discharged through said passageways into the classifier should be substantially the same as the velocity of the primary feed, although the volume of such secondary gases may be materially less.

An experimental classifier of the character described hereinabove contained a classification zone by which the bore 21 had a diameter of 16 inches. It was provided with eight primary conduits and eight secondary conduits. 510 cubic feet of primary air was supplied per minute and 275 cubic feet of secondary air per minute. Diatomaceous earth, previously disintegrated, was introduced with the primary air at the rate of 16 pounds per minute. The milled diatomaceous earth so introduced into the classifier contained 3.2% of 150 mesh and 9.9% by weight of particles larger than 20 microns (in sedimentation characteristics). After separation, it was found that 39.7% of the material fed was discharged in the form of large and heavy particles through the valved outlet 12; 60.3% of the feed was carried over as final product. The coarse product contained 6.0% by weight larger than 150 mesh and 24.3% by weight larger than 20 microns. The final product discharged through the conduit 13 contained only 0.8% larger than 150 mesh and 3.8% larger than 20 microns.

The velocity of gases introduced into the classifier may range from about 1,000 to 12,000 feet per minute and in the experimental device described hereinabove the velocity was about 2,000 feet per minute. The velocity used will, of course, depend upon the specific gravity of the materials treated and the degree of classification required.

I claim:

1. In a classifying and separating apparatus, the combination of a substantially cylindrical classifier provided with substantially vertical walls; a closure for the top of said classifier; a plurality of tangentially arranged inlet conduits communicating with the upper portion of said classifier; means for supplying a fluid suspension of disintegrated material to said inlet conduits; a plurality of tangentially arranged secondary inlet conduits communicating with the lower portion of the classifier; conduit means for supplying fluid to said secondary inlet conduits to form a vortex in said classifier; a downwardly and inwardly directed funnel member provided with an outwardly and downwardly extending lip positioned below said classifier with the lip spaced from the lower edges of said classifier; a housing for said funnel member, and a discharge conduit extending into said housing and terminating at the lower end of said funnel member.

2. In a classifying and separating apparatus, the combination of: a substantially cylindrical classifier provided with a top closure and a downwardly extending housing of larger internal cross sectional area, at a plane immediately below said classifier, than the internal cross sectional area of said classifier; means for introducing fluid bearing disintegrated material in suspension tangentially into the upper portion of said classifier; means for tangentially introducing secondary fluid into the lower portion of the classifier whereby a vortex is formed in said classifier, the bottom of said vortex being open; and a discharge conduit extending into said housing and communicating with the lower and central portion of said classifier whereby the central and lower portions of the vortex and suspension of finer particles in fluid comprising the same may be separately drawn off.

3. In a classifying and separating apparatus, the combination of: a substantially cylindrical classifier provided with a top closure and a downwardly extending housing of larger internal cross sectional area, at a plane immediately below said classifier, than the internal cross sectional area of said classifier; means for introducing fluid bearing disintegrated material in suspension tangentially into the upper portion of said classifier; means for tangentially introducing secondary fluid into the lower portion of the classifier; a discharge conduit extending into said housing, said conduit terminating at the lower and central portion of said classifier; and means carried by the upper end of said discharge conduit and spaced from the lower edge of the classifier for directing larger and heavier particles outwardly into said housing.

4. In a classifying and separating apparatus, the combination of: a substantially cylindrical classifier provided with a top closure and a downwardly extending housing of larger internal cross sectional area, at a plane immediately below said classifier, than the internal cross sectional area of said classifier; means for introducing fluid bearing disintegrated material in suspension tangentially into the upper portion of said classifier;

means for tangentially introducing secondary fluid into the lower portion of the classifier; a discharge conduit extending into said housing and communicating with the lower and central portion of said classifier; and means carried by the upper end of said discharge conduit and spaced from the lower edge of the classifier for directing larger and heavier particles outwardly into said housing, said means having a diameter at their upper edge of not less than $\frac{1}{2}$ the internal diameter of the lower portion of said classifier.

5. In a classifying and separating apparatus particularly adapted to efficiently separate lighter and finer particles from a heterogeneous mixture containing such particles, the combination of a cylindrical chamber provided with a closed top and an open bottom, a plurality of circumferentially arranged ports in the walls of said cylindrical chamber, means for introducing fluid bearing disintegrated material in suspension tangentially into the upper portion of said classifier chamber through certain of said ports to form a vortex within said chamber, means for tangentially introducing secondary fluid into the lower portion of said cylindrical chamber through other of said ports, two concentric outlets at the bottom of said cylindrical chamber, and a hopper surrounding said outlets, the outer annular outlet being adapted to discharge heavier and larger particles into the hopper, the inner outlet communicating with an outlet conduit.

6. In a classifying and separating apparatus, the combination of a cylindrical classifier provided with a closed top and an open bottom, a plurality of ports circumferentially arranged in the walls of said classifier, means for tangentially introducing fluid bearing disintegrated material in suspension into the upper portion of said classifier through certain of said ports, means for tangentially introducing secondary fluid into the lower portion of the classifier through other of said ports, a downwardly extending hopper connected to the bottom of said cylindrical classifier, and an outlet conduit extending into said hopper and terminating in a plane passing through the bottom of the ports in the walls of said classifier, said outlet conduit being concentrically positioned with respect to said cylindrical classifier, the upper edges of said conduit being slightly spaced from the lower edges of said cylindrical classifier to form an annular port through which heavier particles may be discharged from said classifier into said hopper.

7. In a classifying and separating apparatus, the combination of: a substantially cylindrical classifier provided with a closed top, a housing below said classifier, a conduit for supplying a gas bearing disintegrated material in suspension to said classifier, a plurality of circumferentially spaced and tangentially directed inlet ports in the upper section of said classifier, a plurality of conduits connecting said ports with said supply conduit, means for distributing fluid bearing disintegrated material in suspension from said supply conduit to said plurality of conduits, means for tangentially introducing secondary fluid into the lower portion of the classifier, and a discharge conduit provided with an intake port positioned axially of said classifier, said intake port lying in a plane not materially below said means for tangentially introducing secondary fluid.

8. In a classifying and separating apparatus, the combination of: a substantially cylindrical classifier provided with a closed top, the internal

diameter of said classifier being greater than the height thereof, a housing below said classifier, said housing having a larger internal cross-sectional area at a plane immediately below said classifier than the internal cross-sectional area of said classifier, a plurality of tangentially directed circumferentially spaced inlet ports in the upper portion of said classifier, means for supplying fluid bearing disintegrated material in suspension to said ports, a plurality of tangentially directed secondary fluid inlet ports in the lower part of said classifier, means for supplying secondary fluid to said secondary ports, and a discharge conduit provided with an intake port axially positioned with respect to said classifier, said intake port in said discharge conduit lying in a plane virtually coincidental with the plane of the lower edges of said secondary fluid inlet ports.

9. In a classifying and separating apparatus, the combination of: a substantially cylindrical classifier provided with a closed top, the internal diameter of said classifier being greater than the height thereof, a housing below said classifier, said housing having a larger internal cross-sectional area at a plane immediately below said classifier than the internal cross-sectional area of said classifier, a plurality of tangentially directed circumferentially spaced inlet ports in the upper portion of said classifier, means for supplying fluid bearing disintegrated material in suspension to said ports, a plurality of tangentially directed secondary fluid inlet ports in the lower part of said classifier, means for supplying secondary fluid to said secondary ports, a downwardly and inwardly directed funnel member positioned axially with respect to said classifier, the upper edge of said funnel member lying in a plane virtually coincidental with the lower edge of said classifier, a downwardly and outwardly extending apron carried by the upper edge of said funnel member and extending to a point beneath the lower edge of said classifier, and a discharge conduit extending through said housing and communicating with the lower edge of said funnel member whereby fluid may be discharged from said classifier.

10. In a classifying and separating apparatus, the combination of: a substantially cylindrical classifier provided with a closed top, a housing below said classifier, said housing having a larger internal cross-sectional area at a plane immediately below said classifier than the internal cross-sectional area of said classifier, a plurality of tangentially directed and circumferentially spaced ports in the upper portion of the classifier, means for distributing fluid from a supply conduit into a plurality of conduits, a plurality of conduits connecting said plurality of ports with said distributing means, a supply conduit adapted to supply fluid bearing disintegrated material in suspension to said distributing means, a plurality of circumferentially spaced and tangentially directed secondary fluid ports in the lower portion of said classifier, means for supplying secondary fluid to said ports, a downwardly and inwardly directed funnel member positioned axially with respect to said classifier, the upper edge of said funnel member lying in a plane virtually coincidental with the lower edge of said classifier, and a discharge conduit extending through said housing and communicating with the lower edge of said funnel member whereby fluid may be discharged from said classifier.

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