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2,214,905

COLLECTING AND CLASSIFYING MILL

Filed Dec. 23, 1937

2 Sheets-Sheet 1

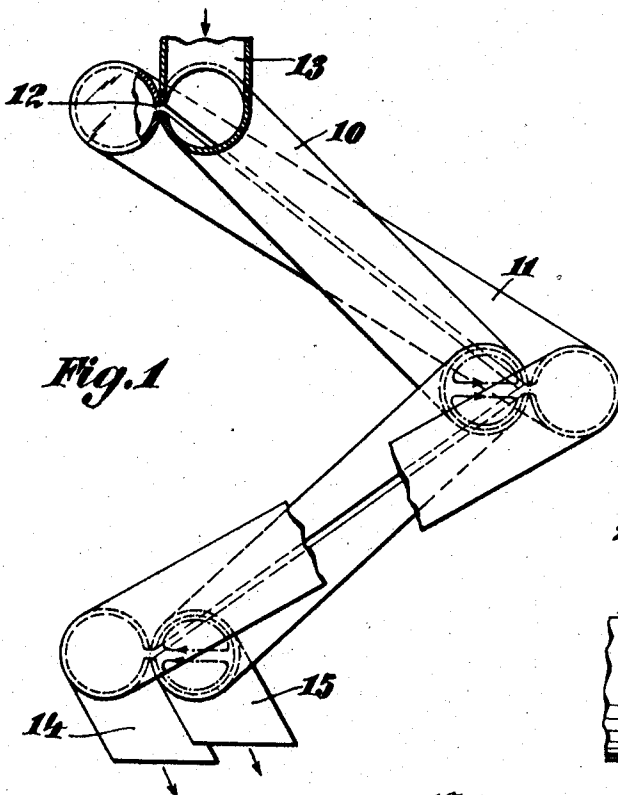


Fig. 1

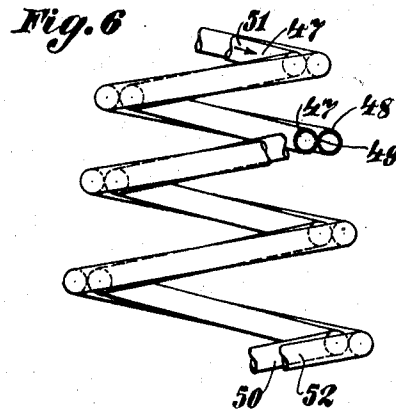


Fig. 6

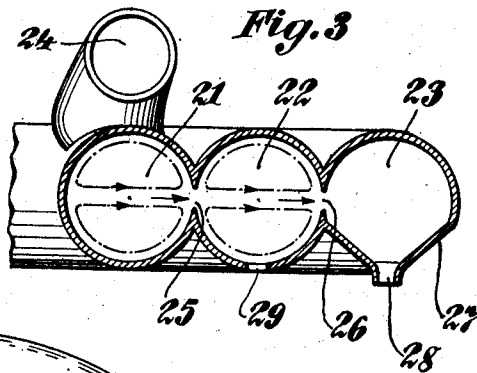


Fig. 3

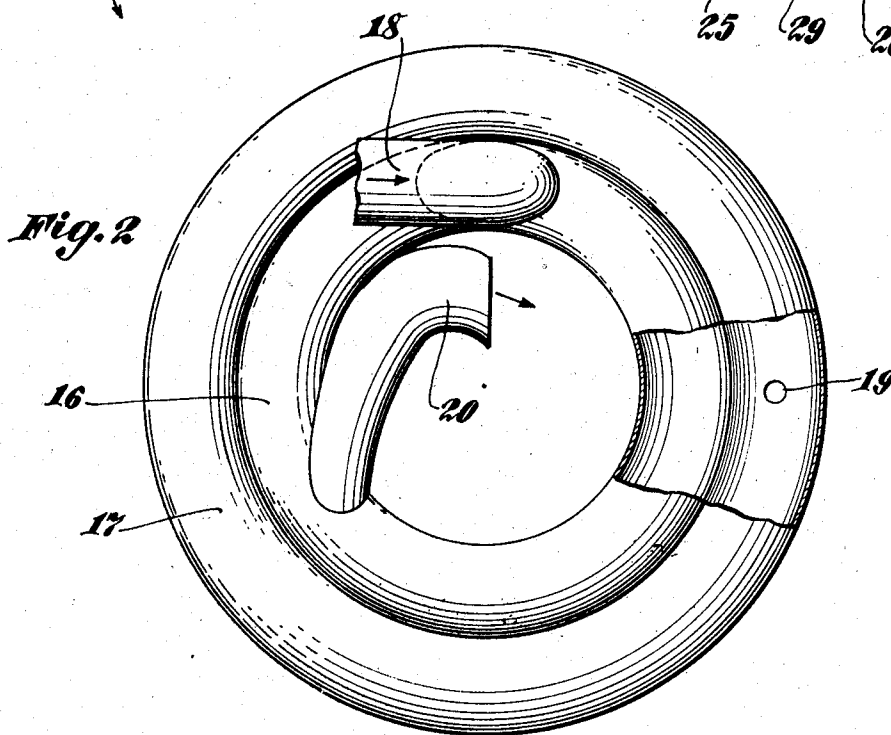


Fig. 2

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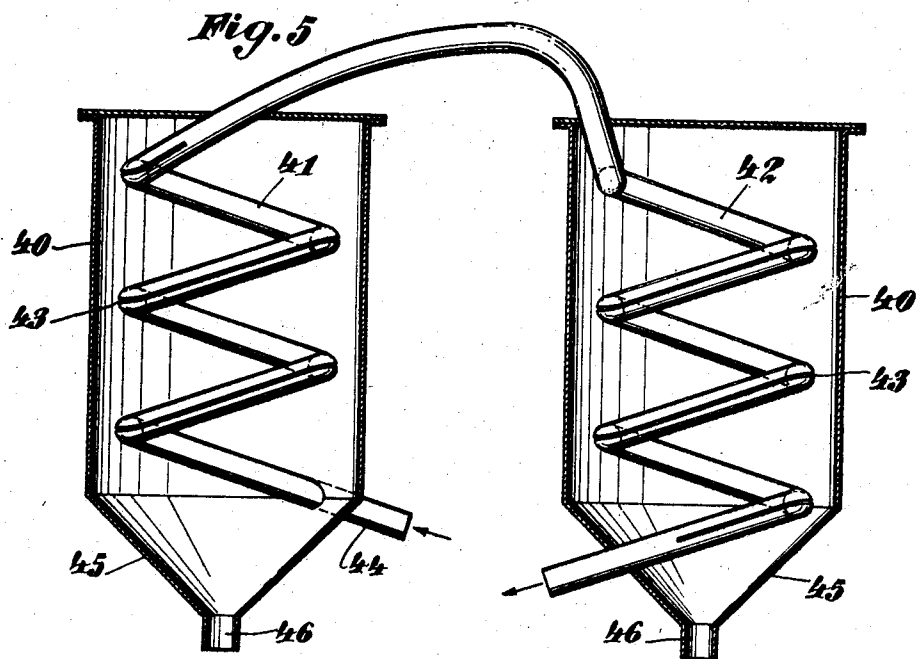
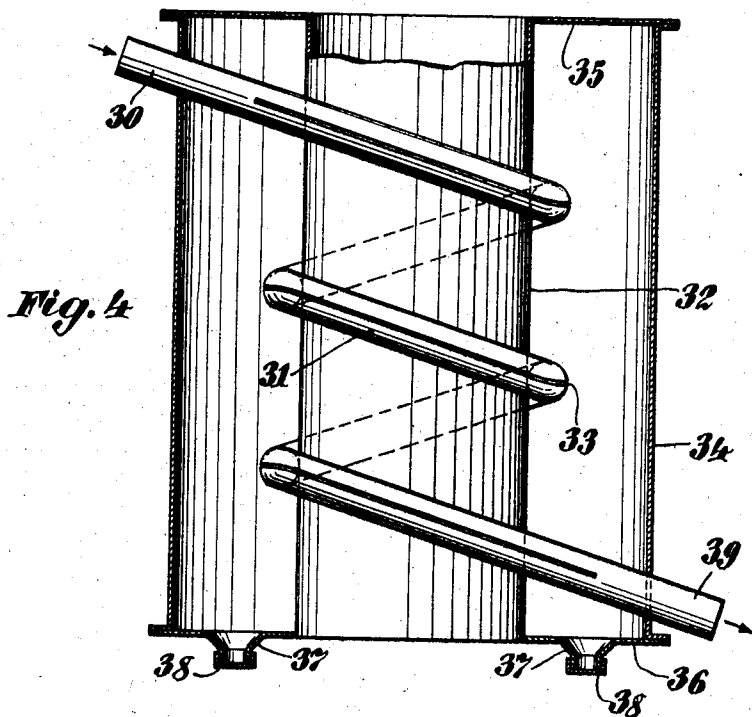
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2 Sheets-Sheet 2



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COLLECTING AND CLASSIFYING MILL

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Application December 23, 1937, Serial No. 181,259

6 Claims. (Cl. 209—143)

This invention relates to an apparatus for separating and classifying the particles of a finely divided material according to their respective sizes.

More specifically it comprehends the separation and classification of materials which have been reduced to a finely divided state by grinding or a similar process of attrition, and which are suspended in a fluid medium for ease of transmission and grinding during the process.

An attrition process of the above character is disclosed in my copending application Serial No. 86,426, applied for jointly with Nicholas N. K. Stephanoff, joint inventor with me of the invention presented therein. In the above-mentioned process the material to be reduced is fed into one end of a curved tubular device through the agency of a high velocity stream of fluid, preferably a gas. The velocity of the entering fluid is so chosen that the velocity of the combined fluid and material is at all times less than, or at most equal to the critical velocity, so that a stream line flow of the material and the fluid medium in which it is suspended is maintained in the tubular device. The passage of the combined fluid medium and material through the curved portions of the tubular device at high velocity gives rise to a centrifugal force which together with the effect of skin friction on the walls of the classifier causes the mass of material and fluid in the central portion of the tube to be forced toward the outer wall thereof. This gives rise to the phenomenon termed "double inverse flow" in the above identified copending application, in which the fluid is given two rotational movements such that in any cross sectional plane through curved sections of the tubular device, half the fluid rotates in a clockwise direction, whereas the other half rotates in a counterclockwise direction. In the central portion of the plane through the tube, the flow of both halves is the same and is in the direction of the centrifugal force causing the motion. This peculiar motion of the fluid medium causes the particles of the material to rub vigorously against one another so that they are reduced to a very fine state of division during the process of attrition.

The "double inverse" flow of the fluid medium is utilized in this invention to provide for the separation and classification of the finely divided material which is discharged from a classifier of the character briefly described above.

An object of the invention, accordingly, is to provide a novel means for the rapid and effective

separation and classification of finely divided materials according to relative particle sizes.

A further object of the invention is to provide an apparatus of the above character in which the finely divided material is suspended in a fluid medium and the separation and classification is accomplished by the combined action of centrifugal force and by double inverse flow of the medium in which the particles are suspended.

Another object of the invention is to provide an apparatus of the above character in which the classification is aided by the effect of the force of gravity on the particles of finely divided material.

In accordance with the present invention, the finely divided material, suspended in a fluid medium, is fed to a curved tubular classifier which is provided with an axial slot in its periphery. The heavier and larger particles in suspension, due to the double inverse motion of the fluid aided by the centrifugal force acting, are discharged through the axial slot, while the finer material continues through the classifier. In this manner the larger particles may be separated from the finer ones, or particles of varying degrees of fineness may be separated and collected as indicated below.

Additional objects will be apparent from the following detailed description and from the accompanying drawings in which:

Fig. 1 is a view in front elevation of a helical classifier constructed in accordance with this invention.

Fig. 2 is a top view of a modified classifier constructed in accordance with the invention, in which the device is formed with several concentric tubular portions.

Fig. 3 is a view in section illustrating a further modification of the classifier, for obtaining several degrees of fineness.

Fig. 4 is a view in section illustrating a modification in which a collecting chamber is substituted for the helical collecting chamber disclosed in Fig. 1.

Fig. 5 is a view in partial section illustrating an adaptation of the construction of Fig. 4 in which two separate devices are used to obtain classification and collection.

Fig. 6 is a view in partial section illustrating an adaptation of the construction of Fig. 1 in which a pair of helices of varying radii are used to obtain separation and collection.

Referring to Fig. 1 a collector is shown formed by a helical coil 10 to which is secured a second collector coil 11 in such fashion that the two are

continuously tangent along their entire length. At the point of tangency of the two coils a slot 12 is formed which communicates between the two coils 10 and 11. Finely divided material suspended in a fluid medium enters the coil 11 through the passage 13 in the direction indicated by the arrow, whence it flows downwardly through the classifier.

The centrifugal force created by the movement of the fluid in the helical coil 10 in conjunction with the double inverse flow of the fluid outlined above, and more fully described in my above identified copending application, causes the coarser particles in suspension to move toward the outer wall of the coil 10 whence they are discharged through the slot 12 into the collector coil 11. The angle of the helix generated by each coil should be greater than the angle of repose for the material collected so that the latter will readily slide along the surface of the collector coil 11 from which it will be discharged through the outlet 14. The finer particles in suspension will remain in the coil 10 and will continue downwardly until they are discharged along with the fluid medium from the outlet 15. It is obvious that by varying the length of the collector coils the amount of material separated from the fluid medium can be controlled within reasonably close limits, and if desired all the material may be discharged from the outlet 14 leaving the clear fluid to pass through the outlet 15. If desired, the outlet 14 may be provided with a valve through which the material may be valved off as desired.

In Fig. 2 a modified form of the collecting apparatus is shown which is formed of the two concentric coils 16 and 17 respectively, the outer surface of coil 16 being tangentially in contact with the inner surface of coil 17. As in Fig. 1, a narrow continuous slot is formed at the point of tangency of the two coils, which communicates therebetween. The finely divided material in fluid suspension enters through the inlet passage 18 from which it passes to the coil 16. As it travels through passage 18, due to the combined effects of centrifugal force and double inverse flow, the coarser material moves toward the outer surface of the coil 16 and is eventually discharged into the coil 17 through the slot formed between the two coils. Spaced in the bottom of coil 17 are a number of apertures 19, through which the collected coarser material may pass into a suitable container. The fluid medium continues on, and is discharged through the outlet 20 as clear fluid or containing a small amount of very finely divided material in suspension depending upon the rate of flow through the collecting device and the length thereof.

As illustrated in Fig. 3 the collecting classifier shown in Fig. 2 may be provided with three coils 21, 22 and 23 respectively in order to obtain several varying degrees of fineness in the collected product or more complete collection. As before, the fluid bearing material enters at the inlet 24 from which it is fed into the coil 21. Due to the joint action of centrifugal force and the double inverse flow of the fluid medium, the coarser and heavier particles are thrown against the outward portion of the coil in the direction of the arrow, through a communicating slot 25 formed between coils 21 and 22. In this modification, double inverse fluid flow is also maintained in the second coil 22, so that with this construction also, the relatively coarser particles are thrown against its outer surface in the

direction indicated by the arrow. They then pass into the hopper-shaped coil 23, through a slot 26 formed between coils 22 and 23. Since any fluid flow in this latter coil will be such as not to prevent the collection of the particles therefrom, the coarse and relatively heavy material drops upon the inclined surfaces 27 of the hopper shaped coil 23, and is discharged through the opening 28 in the bottom thereof. The particles which have collected in coil 22 fall downwardly and are discharged through spaced openings 29 formed in the inner surface of this coil. With this construction, therefore, it is possible to collect the finely divided material in three different stages of classification, which may be controlled as mentioned above by varying the fluid velocity through the coils and also by changing their respective lengths.

In the modification shown in Fig. 4, the fluid and suspended material may be fed into either end 30 or 31 of a helical coil 31, which is wound about the external surface of a cylindrical member 32. The coil 31 is formed with a continuous axial slot 33 which extends almost the entire length of the coil, and through which the relatively coarse material is discharged as described above. About the cylindrical member 32 a cylindrical collecting chamber 34 is formed and is provided with a cover plate 35 and a base plate 36 in which the discharge openings 37 are formed. The discharge openings 37 are provided with caps 38 which may be intermittently withdrawn to remove the material which has collected in the chamber 34. The fluid medium in which the finely divided material was originally suspended, if fed in through the end 30, is discharged through the outlet 39 which forms the lower extremity of the helical coil 31. In this modification also, the relative amount of finely divided material discharged with the fluid medium can be controlled by varying the length of the helical coil 31, and also to some extent, by varying the velocity of the fluid medium therein.

The collecting device of this invention is illustrated in a further modification in Fig. 5 which is adapted to permit the separation and classification of the finely divided and suspended material into two or more classes. It comprises the two collecting chambers 40, in each of which two helical coils 41 and 42 are mounted as shown. Both of the helical coils 41 and 42 are formed with continuous axial slots 43 through which the relatively coarse suspended material is adapted to be discharged.

The material-bearing fluid medium enters through the lower extremity 44 of the helical coil 41, and as it passes upwardly therethrough the heavier or coarser particles are discharged through the slot 43 into the collecting chamber 40. Here they fall downwardly by gravity upon the funnel shaped surfaces 45 of the collecting chamber 40, whence they are discharged through the passage 46 to a suitable container. Any number of similar classifiers may be connected in series in order to obtain as many grades of classification as may be desired, and it is possible in this manner to remove substantially all of the finely divided material which was originally suspended in the fluid medium.

In the embodiment shown in Fig. 6, the collector comprises a helical coil 47 to which a collector coil 48 is tangentially secured, and between which a continuous communicating slot 49 is formed. It will be noted as each helix rises its radius decreases, so that the centrifugal force

acting on the material-bearing fluid which passes through the helical coil 48 will increase due to the reduction in the radius of curvature. The material-bearing fluid may be supplied to the collector at the portion of the helix which has the least radius, in which case, the centrifugal force acting on the particles of material will decrease as they pass downwardly through the classifier. In this case the greater part of the material is thrown out through the slot 49 in the upper portion of the apparatus where the centrifugal force is greatest, the remaining portion being removed as it progresses downwardly through the classifier, so that all of the material may be removed and clear fluid may be discharged from the lower opening 50.

The material-bearing fluid may also enter the device through the lower extremity 50, in which case the heavier particles will be removed in the lower part of the device where the centrifugal force is least, while the lighter material particles will be removed in the upper section where, due to the decreased radius, the centrifugal force is relatively greater. The clear fluid will then be discharged from the upper extremity 51 while the separated and collected material will be discharged through the lower extremity 52 of the collector tube 48. In this modification also, the helix angle is chosen to be greater than the angle of repose for the material collected, so that the latter will readily slide down the collector tube 48 to the discharge opening 52.

It is evident that in any of the modifications shown the helical tube which constitutes the main element of the classifier may be constructed to decrease in diameter along its length or increase in diameter depending on the results desired. For example, in the modification shown in Fig. 3, the second coil 22 may be made of slightly less diameter than coil 21 to increase the effect of the double inverse flow of the fluid medium in coil 22, a feature which must be considered in view of the fact that the heaviest particles have been removed. Similarly if it is desired to gradually reduce the effect of the double inverse flow, the coil 22 may be made of larger diameter than the coil 21 to secure the desired result.

This invention provides a means whereby finely divided materials may be rapidly and effectively classified into as many different particle sizes as may be required, and as pointed out above, it is possible to remove substantially all of the material from the fluid medium so that the process may be practiced with great economy.

Obviously the invention described herein may be used in connection with apparatus, the purpose of which is either to separate or classify or both, and the use of these terms herein is not to be considered as limiting the use or scope of the invention.

While a specific embodiment has been described above, the invention is not to be in any way limited thereby except as defined in the following claims.

I claim:

1. A device for separating and classifying finely divided material suspended in a fluid medium, comprising a coiled, tubular member of substantially circular cross section adapted under proper flow velocities to cause the fluid to flow in a plurality of paths, means to supply material-laden fluid to the said tubular member, a second coiled tubular member of substantially circular cross section concentric with the first member

about a common center of curvature, and tangent to the outer wall of the periphery of said first member for receiving the separated material, and a communicating slot between the two said members formed in the tangential portion to cooperate with the said fluid flow for removing a portion of finely divided material from the said fluid medium and for directing the removed material to the said second tubular member.

2. A device for separating and classifying finely divided material suspended in a fluid medium, comprising a plurality of helical, tubular members of substantially circular cross section concentrically disposed about a common axis and respectively tangent to one another, at least one of which is adapted to cause the fluid to flow in a plurality of paths, means to supply material-bearing fluid to one of the said tubular members, and longitudinally extending communicating slots between the said tubular members, in the tangential portions thereof, to cooperate with the said fluid flow for removing a portion of finely divided material from the said fluid medium, and for directing the said removed material to a second tubular member.

3. A device for separating and classifying finely divided material suspended in a fluid medium, comprising a plurality of helical, tubular members concentrically disposed about a common axis, and respectively tangent to one another at their peripheries, at least one of which is adapted to cause the fluid to flow in a plurality of streamline paths, means to supply material-bearing fluid to one of the said tubular members, communicating slots between the said tubular members in the tangential portions thereof, to cooperate with the said fluid flow for removing a portion of finely divided material from the said fluid medium, and for directing it to a second tubular member, the helix angle of the said tubular members being greater than the angle of repose for the finely divided material to facilitate its discharge from the device.

4. A device for separating and classifying finely divided material suspended in a fluid medium comprising an elongated, tubular member of substantially circular cross section having a helical portion adapted to cause the fluid to flow in a plurality of paths including adjacent portions which are parallel and unidirectional in a direction away from the center of curvature of the member, means to supply material-laden fluid to the said tubular member, a continuous axial slot formed in the periphery of and substantially co-extensive in length with said helical portion of the said tubular member to cooperate with the said fluid flow, for removing a portion of finely divided material from the said fluid medium, and a chamber about the said tubular member for collecting the material so removed.

5. A device for separating and classifying finely divided material, suspended in a fluid medium, comprising a plurality of curved, elongated tubular members, concentrically disposed about a common axis and respectively tangent to one another so that one is outwardly positioned with respect to a plurality of other inwardly disposed members, the said inner tubular members being adapted to cause the fluid to flow in a plurality of paths, means to supply the material bearing fluid to the innermost of the said inner tubular members, communicating slots between the tubular members in the adjacent tangential portions thereof to cooperate with the said fluid flow, whereby the heavier material is directed through

the said slots into the tubular member disposed outwardly thereof, said outermost inner tubular member being formed with an aperture through which material may be removed therefrom for collection, communicating slots between the outermost inner tubular member and the aforementioned outwardly positioned tubular member in the tangential portions thereof cooperating with the fluid flow whereby the heavier material is directed through the slot in the second inner tubular member into the outer tubular member, and means to remove and collect material from the said outer tubular member.

6. A device for separating finely divided ma-

terial in a fluid medium, comprising a coiled tubular member of substantially circular cross section having a narrow slot extending along its length in its outer periphery, the said member being adapted to cause the fluid to flow in a plurality of paths including portions which are parallel and unidirectional in a direction toward the said slot, means to supply material laden fluid to the member, and collector means extending substantially the length of the member and over the slot to receive finely divided material from the fluid medium.

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