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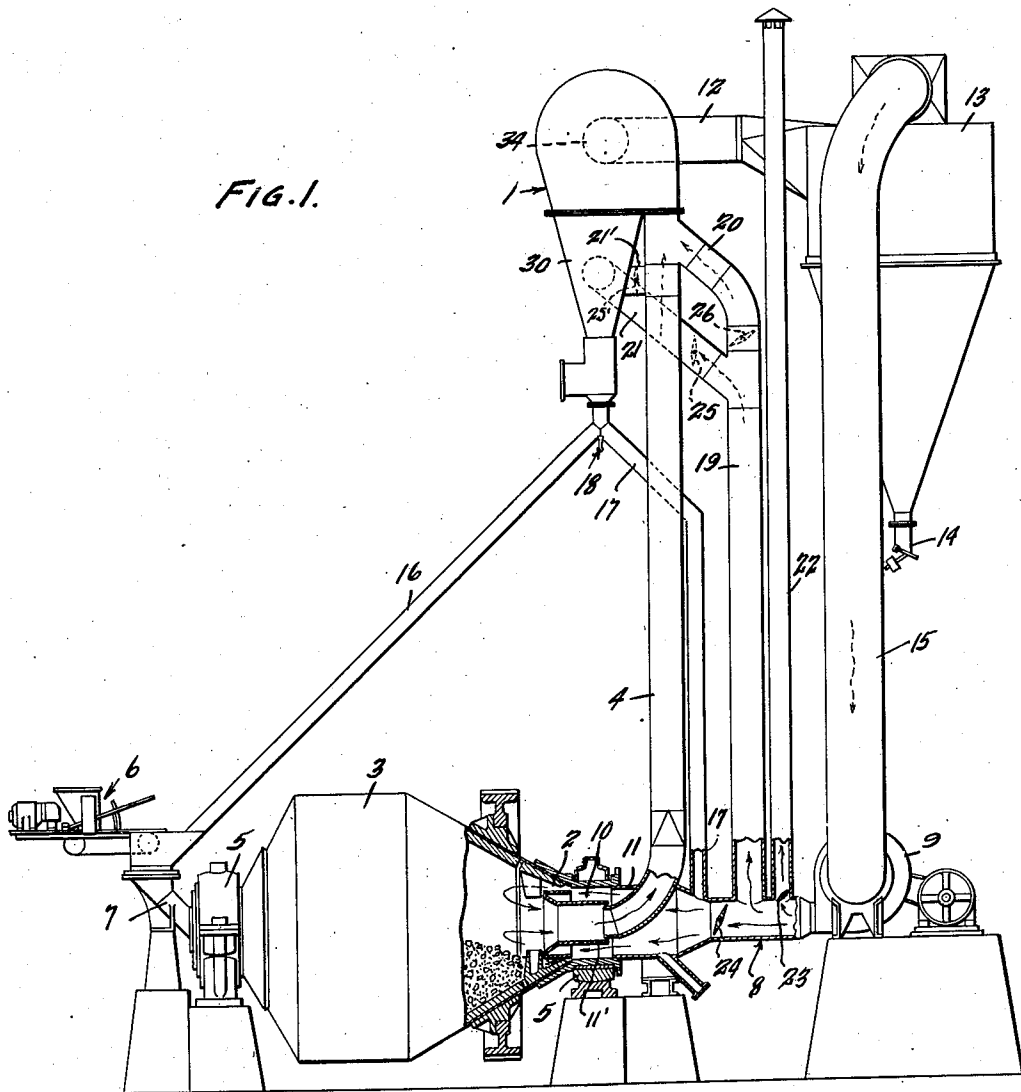
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CLASSIFYING SYSTEM FOR PULVERIZED MATERIALS

Filed Aug. 3, 1940

3 Sheets-Sheet 1



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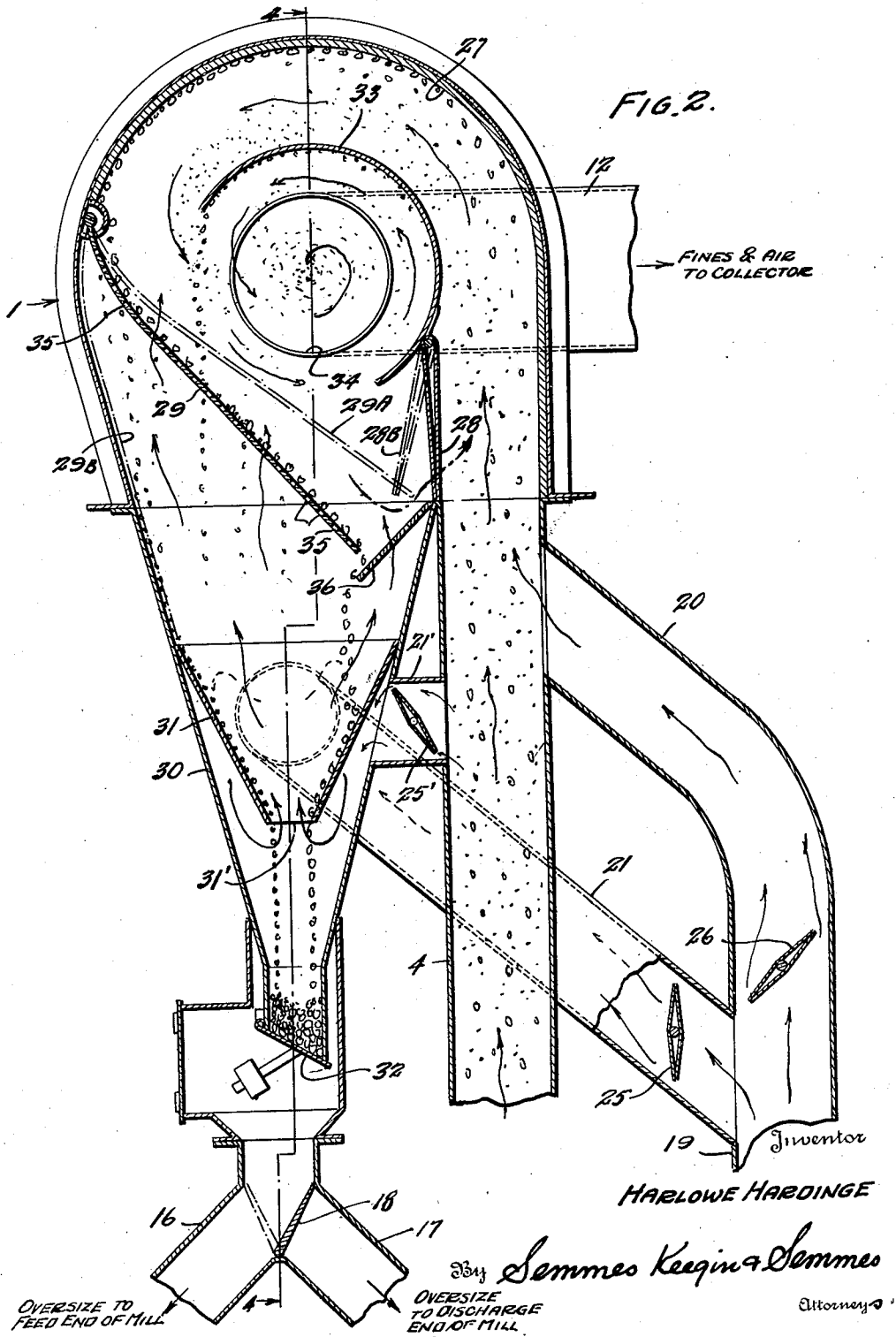
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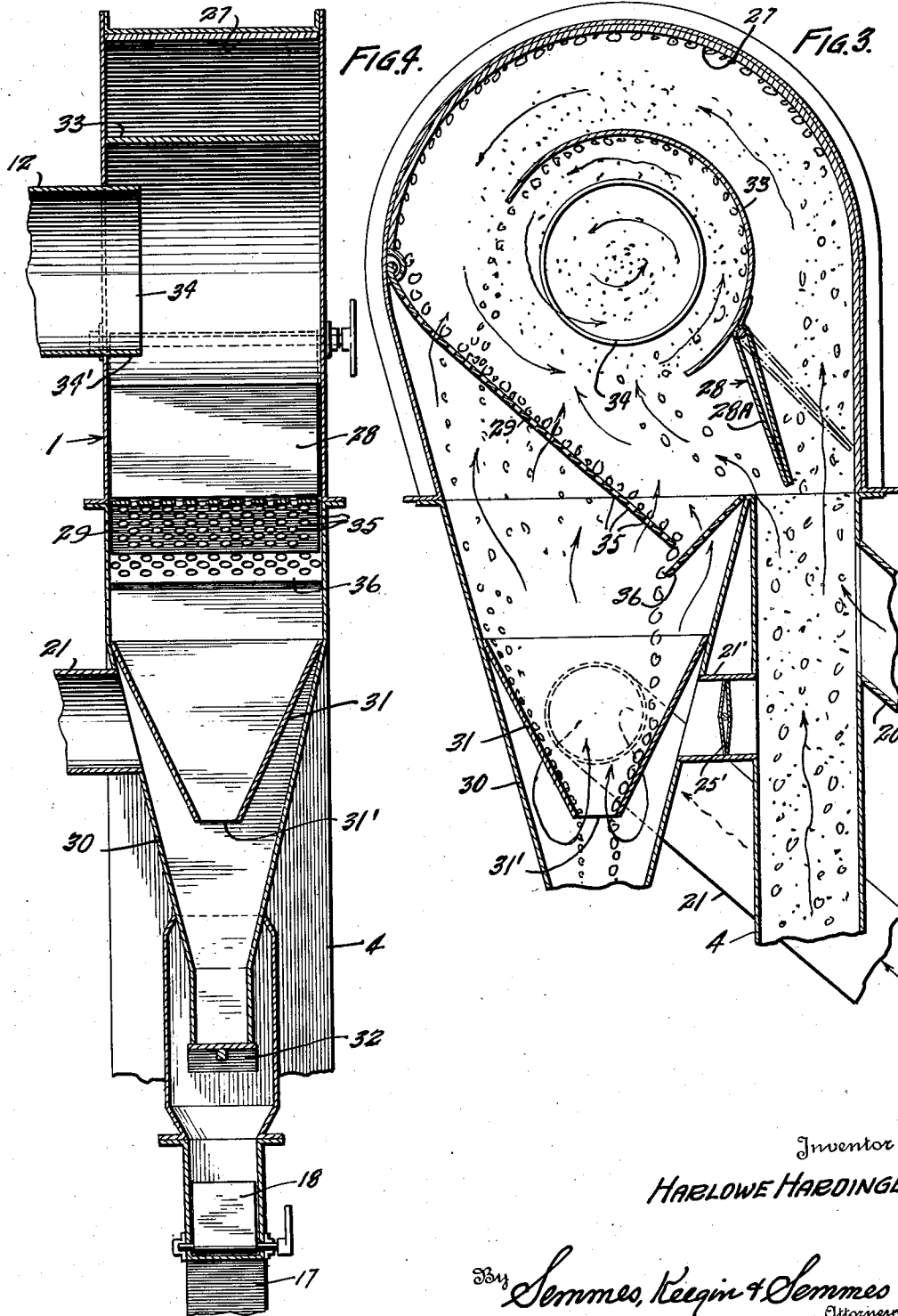
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2,381,954

CLASSIFYING SYSTEM FOR PULVERIZED MATERIALS

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Application August 3, 1940, Serial No. 350,737

16 Claims. (Cl. 209—144)

The present invention relates to classifiers and more particularly to classifiers such as are used in the classification and extraction of coarse material and fine material from a body of material-laden air or other buoyant or elastic fluid capable of carrying particles in suspension. While my inventive concept finds especial application in connection with grinding mills, it is of course apparent that it is of broader scope.

Heretofore classifiers of the type under consideration have usually been of the double cone two-compartment variety such as shown and described in my Patents Nos. 1,709,848 and 1,721,594, granted April 23, 1929, and July 23, 1929, respectively. While this earlier type classifier has proven commercially successful, the present invention embodies features differing in principle from the foregoing and other types of classifiers used for the same general purpose.

An object of the present invention is to provide an improved system of classifying in connection with grinding mills wherein a simplified method of classifying oversize from the fines discharged from the mill is employed and whereby the oversize may be returned either to the feed end or discharge end of the mill.

Another object of the present invention is to utilize the principle of centrifugal force in classification, which force can be varied without changing the quantity of air employed by means of splitting the air current into two or more components and re-combining so that one component opposes the other.

Yet another object of the present invention is to provide a method of classification whereby centrifugal force is used to effect a separation of the oversize from the fines in which some of the fines going with the oversize are re-classified by means of the hindered settling principle of classification.

A further object is to provide a method of classification whereby the centrifugal force utilized to effect the classification is varied by the quantity of air supplied.

And yet another object is to provide a classification device which is simple in construction, which can be cheaply and easily manufactured and which is economical to maintain.

With these and other objects in view, which may be incident to my improvements, the invention consists in the parts and combinations to be hereinafter set forth and claimed, with the understanding that the several necessary elements comprising my invention may be varied in construction, proportions and arrangements, with-

out departing from the spirit and scope of the appended claims.

In the drawings in which like numerals indicate the same or similar parts:

Figure 1 is an elevational view partly broken away illustrating the operative relation of the classifier with a grinding mill.

Figure 2 is a transverse sectional view of the classifier.

Figure 3 is a transverse sectional view of the classifier showing the damper moved to the position whereby it splits the material-laden airstream.

Figure 4 is a sectional view taken along the line 4—4 of Figure 2.

Referring to the drawings, and more specifically to Figure 1, I have shown a classifier 1 which is directly connected through a suitable conduit to discharge end 2 of a mill 3, from which a continual flow of material-laden air is withdrawn into a pipe 4. The mill 3, while shown here as the well known conical mill, may also be of any conventional design such as a cylindrical mill, rod mill, hammer mill, etc.

The coarse material is fed into the mill by a feeder 6 through a chute 7. Air is delivered to the mill through a conduit 8 by means of a blower 9 and enters the mill in an annular space 10 between a large portion 11 of the conduit 8 and the central outlet pipe or conduit 11'. To improve the grinding action of the mill 3, an extra quantity of air is introduced more or less to clean the load of ground material and thereby remove along with the ground material a quantity of oversize. The fine and oversize material is drawn up through the pipe 4 into the classifier 1 where the oversize is removed from the fines in a manner hereinafter to be more fully described. The fines are withdrawn from the classifier through a discharge pipe 12 into a product collector 13 wherein the fine solids are separated from the air. The solids are discharged from the system through an air lock 14 of conventional design whereby the pressure of the material in the collector opens the valve of the lock as the load builds up in the bottom of the collector. However, as the bottom of the air lock is loaded with material, air will not pass up at this point and the system is kept virtually free of infiltration of outside air. The air from the product collector is returned to the blower 9 through a conduit 15 for re-circulation through the system.

The oversize from the classifier 1 is returned either to the feed end of the mill 3 by a pipe 16 or to the discharge point through a pipe 17. If

desired, part of the oversize is delivered to the pipe 16 and part to the pipe 17 by means of a suitable dividing vane indicated generally at 18.

A conduit 19 functions as a bypass whereby part of the air from the blower 9 may be delivered directly to the classifier 1 rather than through the mill 3. The air will enter the classifier either at a point joining the material-laden air as indicated at 20, or at the bottom of the classifier through a conduit 21, as clearly shown in Figure 2. The advantages of the by-passed air entering the classifier through the conduits 20 and 21 will later be more completely set forth.

To compensate for the infiltration of air in the vacuum side of the system where leaks might possibly occur and also at the feed end of the mill where a slight indraft is desirable, a vent 22 is provided. The vent 22 is located on the pressure side of the blower 9 and has a damper 23 which is adjustable for regulating the amount of air and water vapor, if any is present, that is discharged from the system. In addition, a damper 24 which is located in the main conduit 8 regulates the quantity of air entering the mill 3, and in conjunction with dampers 25 and 26 (Figure 2) in the bypass pipes 21 and 20, respectively, regulate the total volume of air circulating in the system.

Turning now to the classifier operation, the material-laden air will enter the classifier 1 through the conduit 4 with sufficient velocity to carry the coarsest oversize particles up around the semi-circular top or periphery 27 of the classifier. At the entrance of the classifier is a hinged splitting damper 28 that is movable across the upcoming stream to a position indicated by the numeral 28A of Figure 3, or backward to a position shown by the numeral 28B in Figure 2. On the other side of the classifier is a pivoted deflecting plate 29 which may be moved forward to the position indicated by the designation 29A or adjacent to the side of the classifier as at 29B (Figure 2). The deflector plate 29 may be solid, or as shown in the drawings, it may be a perforated plate.

Below the deflecting plate 29 is a hopper 30 for the oversize and an inner hopper 31 having a restricted outlet 31' is also provided. In the bottom of the hopper 30 is an air lock 32 which may be of the same type as the air lock 14 in the product collector 13, but the lock 32 is employed to handle the oversize material delivered from the classifier.

An inner wall segment of a circle extending across the face of the classifier is shown by the numeral 33. An outlet from the classifier for the fines and air is indicated by the opening 34 which is in the form of a sleeve that extends slightly into the classifier as indicated at 34' in Figure 4.

Assuming that the splitting damper 28 is in the full line position shown in Figure 2, the material-laden air in passing between the periphery of the classifier 1 and the circular segment 33 tends to throw out the coarser particles at the periphery due to centrifugal force. These particles slide around the top and down the side and pass over the deflecting damper 29. The particles then pass down into the hopper 30 while the air and finer particles converge in a spiral movement toward the center and out through the opening 34. The higher the velocity of air travel the greater the centrifugal force, and as a consequence larger particles will be thrown out at the periphery. Also, as the air converges toward the center, the centrifugal action causes the air to

rotate rapidly inside of the segment 33 before it passes out of the opening 34, thus further separating the solids from the air. The solids will slide along the segment 33 and will be thrown out at the end in a downward motion eventually dropping out of the circuit and into the hopper 30.

The velocity of the material-laden air is controlled in a number of ways. In the first place, the volume of air throughout the entire system can be effected by the damper 24 (Figure 1) on the pressure side of the blower 9. In the second place, the bypass air entering through the pipes 19 and 20, and controlled by the damper 26, will augment the supply of air and increase the velocity of travel in the classifier 1. In the third place, the splitting damper 28, when moved to the position 28B (Figure 2) will permit part of the air already rotating in the classifier to recirculate in the annular space between the segment 33 and periphery 27, thus increasing the velocity and centrifugal force in the classifier 1.

In order to obtain a coarser product discharged from the classifier through the outlet 34, the vane 28 may be moved to the position shown at 28A, and the material-laden air will be split, part going up and around the space between the periphery 27 and the circular segment 33, and part being short-circuited directly toward the center of the classifier, thus opposing the direction of air flow. The effect of this action is to slow down the circular movement of the air in the classifier both in the annular portion between the periphery 27 and the segment 33 and also in the center adjacent to the outlet pipe 34. The result of this arrangement is that there is a lesser tendency to throw out the solids from the air and as a result, the air discharged from the outlet 34 will contain more solids and coarser particles. By moving the vane 28 to different positions it is obvious that different degrees of centrifugal force may be attained and different fineness of products secured.

It is also possible to vary the fineness by opening the bypass damper 25 in the pipe 21 which enters the space between the outer wall of the hopper 30 and the inner hopper 31. The air passes up through the opening 31' in the hopper 31 counter to the flow of oversize being discharged by gravity. The effect of this action is to clean the oversize of fines that may be thrown down with the coarser particles and thus grade the oversize. The buoying effect of the air passing upwards through the hopper 31 tends to return to the upper section of the classifier particles somewhat coarser than would ordinarily be discharged through the pipe 34 since the more air that passes up through the opening 31' the more will be the buoying effect of the particles of intermediate size, and if they are not allowed to pass through the opening 31' by this action they will eventually go out through the opening 34.

Instead of using relatively clean air from the by-pass pipe 21 and its damper 25, another source of air for the hopper 30 and opening 31' may be derived by by-passing a portion of the material-laden air in the pipe 4 to the hopper 30 through the pipe 21', which air is controlled by damper 25', Figure 2. Such an arrangement may not be as effective in securing oversize relatively free of fines, but the arrangement is simpler, in that the long by-pass pipes 19 and 21 may, under certain conditions, be entirely eliminated, thus reducing the cost of the classifier unit.

The movement of the plate 29 has a definite effect upon the operation of the classifier in that it changes the volume of the classifier between the periphery and the outlet point 34 on the so-called down side of the classifier. Consequently when this plate is in the position shown at 29B, the centrifugal force in the system is somewhat reduced, and becomes disturbed and the product is not as fine as when the plate is in the position 29. Also, in this latter position 29, the deflecting plate divides into two zones the portion where the centrifugal action occurs and the portion where the oversize settles into the hopper by hindered settling.

As a further aid, in the case of certain materials and under certain conditions, the deflector 29 may be perforated as indicated at 35, and a second baffle 36, also perforated if desired, may be used to aid in the gradation of the products produced by permitting the air entering through pipe 21 to pass up in such volume through the opening 31' that it spreads out into the hopper beneath the plate 29 and up through the perforations 35 so as to flow back toward the center of the classifier with an appreciable buoying force. In this manner a further hindered settling effect is secured which permits a definite classifying action along the plate 29 so that coarser sizings may be obtained than would otherwise be possible. Those particles which pass over and along the plate 29 either go directly through the openings in the plate against the airstream or slide down the incline and out at the end of the baffle down into the hopper where they pass through the opening 31' and out of the air lock 32.

While I have shown and described the preferred embodiment of my invention, I wish it to be understood that I do not confine myself to the precise details of construction herein set forth by way of illustration, as it is apparent that many changes and variations may be made therein, by those skilled in the art, without departing from the spirit of the invention, or exceeding the scope of the appended claims.

I claim:

1. A method of classifying coarse materials and fine materials comprising establishing a stream of an elastic fluid carrying coarse and fine materials, splitting said material-laden stream and imparting to one portion thereof a cyclonic motion to throw the coarse material to the periphery of the cyclonic path, reintroducing the other portion to the cyclonic portion adjacent the periphery and intermediate the length of the cyclonic portion to oppose thereby the cyclonic motion, controlling the intensity of the cyclonic motion by varying the quantity of material-laden fluid so reintroduced, removing the coarse material from the cyclonic zone, and removing the fluid freed of the coarse material axially of the cyclonic path.

2. A method as described in claim 1, in which the cyclonic path is established about a substantially horizontal axis, and in which the coarse material is removed from the cyclonic zone radially thereof.

3. A method as described in claim 1 wherein the coarse material thrown out of the stream falls from the cyclonic zone and in which additional fluid is passed counter-current to the movement of said coarse material in a substantially hindered settling fluid column.

4. In an apparatus for sizing materials in an elastic fluid medium, a container having an inlet for material-laden fluid and an outlet for the

fluid from which oversize has been removed, means to establish a cyclonic action of the fluid within the container thereby to throw out the oversize, means to withdraw a portion of the incoming material-laden fluid and to reintroduce it to the material-laden cyclonic fluid thereby to vary the cyclonic action, such withdrawn fluid being reintroduced adjacent the periphery of the material-laden cyclonic fluid, and means to discharge the removed oversize from the container.

5. An apparatus as defined in claim 4 in which the axis of cyclonic action is substantially horizontal and in which the oversize is discharged from the container radially of the axis of the cyclone.

6. An apparatus as defined in claim 4 in which the point of reintroduction of the withdrawn air is in the periphery of and intermediate the length of the cyclonic body of fluid and in a direction substantially opposite to the direction of the fluid in such cyclonic path.

7. A device as defined in claim 4 in which the axis of cyclonic action is substantially horizontal and in which the outlet for the fluid consists of a duct extending into the container axially of the cyclone.

8. An apparatus as defined in claim 4 in which the point of reintroduction of the withdrawn incoming fluid to the fluid in the cyclonic path is in substantially the same plane radially of the axis of the cyclone as the point of introduction of the main body of fluid to said path.

9. An apparatus as defined in claim 3 in which means are provided for introducing material-free fluid to the incoming material-laden fluid.

10. In an apparatus for classifying coarse and fine materials in an elastic fluid medium, a container, an inlet for the material-laden fluid, a damper adjacent the inlet for splitting the incoming fluid, baffle means to curve one of the split portions of fluid and to thereafter establish a cyclonic path for the fluid, the damper being so positioned that the other split portion recombines with the first portion moving in the cyclonic path to vary the intensity of the cyclonic action, an outlet for the fluid located axially of the cyclonic path, means located radially of the cyclonic axis to receive the oversize material removed from the fluid, a restricted discharge opening in the receiver for the oversize, and means to pass a cleaning fluid through said opening in a direction counter to the oversize passing therethrough.

11. In an apparatus for classifying coarse and fine materials in an elastic fluid medium, a container having an arcuate wall, an inlet duct, an arcuate baffle concentrically located with respect to the arcuate wall, an outlet duct spaced inwardly and concentrically with respect to said baffle, the arrangement of said container wall, said baffle and said outlet duct serving to establish a cyclonic path for the fluid within the container, a damper positioned adjacent the inlet to the container and adapted to be moved in one position to split the incoming fluid and thereby decrease the cyclonic action of fluid within the container and to be moved to another position to permit recirculation of fluid intermediate the arcuate wall and baffle, and a hopper member to receive coarse material thrown out of the fluid.

12. In an apparatus for classifying coarse and fine materials, a container, means for moving a body of material-laden elastic fluid in a cyclonic path therein to separate the coarse material from the fines by centrifugal action, a screen-like member forming a portion of the container and

adapted to receive such separated coarse material, and means for directing a stream of cleaning fluid through the screen-like member from the side opposite to that on which said coarse material is deposited and thence into the cyclonic path of fluid thereby to remove fines entrapped with the deposited coarse material and return such fines and cleaning fluid into said cyclonic path.

13. An apparatus such as described in claim 12 in which a hopper communicates with the container and in which the screen-like member is adjustably positioned with respect to the discharge opening from the container into the hopper to vary the size of such discharge opening.

14. An apparatus as described in claim 12 in which the screen-like member is adjustable with respect to the walls of the container to vary the volume of material-laden fluid moving in the cyclonic path.

15. A method of classifying coarse and fine

material comprising establishing a stream of elastic fluid carrying both coarse and fine material, dividing the material-laden stream, imparting to one of the divided portions a cyclonic motion to separate the coarse from fine material, discharging the coarse material from the zone of cyclonic motion, directing the other portion of the divided stream to a region removed from the cyclonic path and into the path of the discharging coarse material to remove fine material entrained therewith, and thence into the cyclonic path to commingle with the fluid in said cyclonic path and discharging the fluid freed from coarse material axially of the cyclonic path.

15 16. A method according to claim 15 in which the separated coarse material is discharged from the cyclonic zone by gravity and in which the last-named divided portion of the stream is directed to the cyclonic path in a rising substantially hindered settling fluid column.

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