Feb. 1, 1955 T. R. MORTON 2,701,056

METHOD AND APPARATUS FOR CLASSIFYING AND CONCENTRATING MATERIALS

Filed Sept. 1, 1951

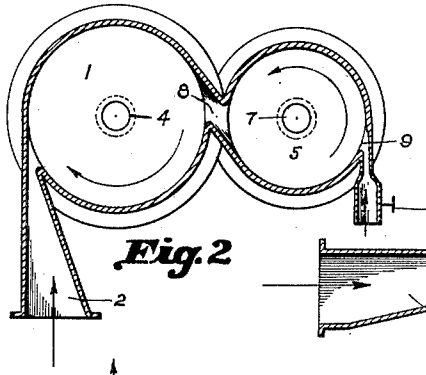


Fig. 2

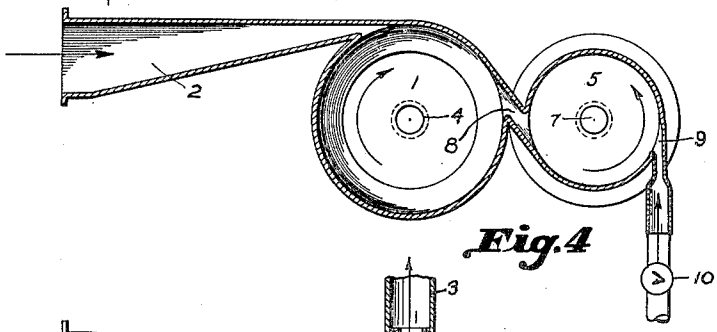


Fig. 4

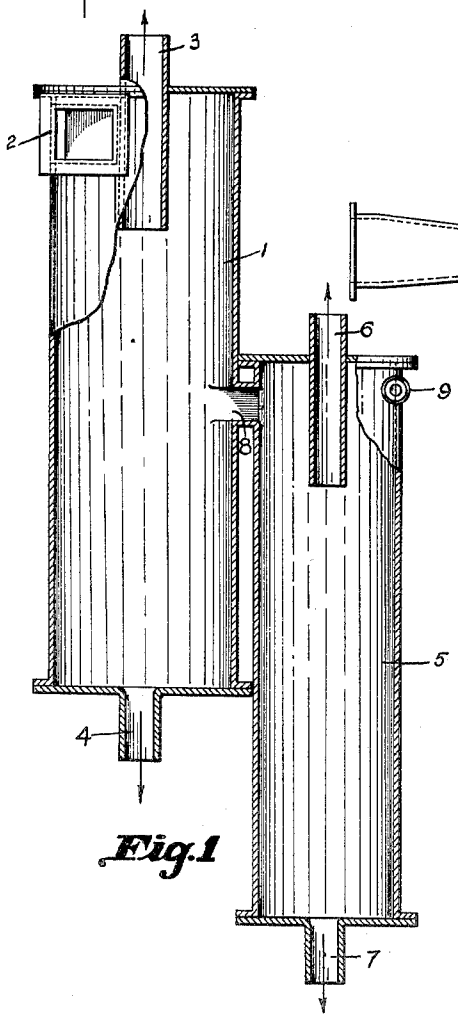


Fig. 1

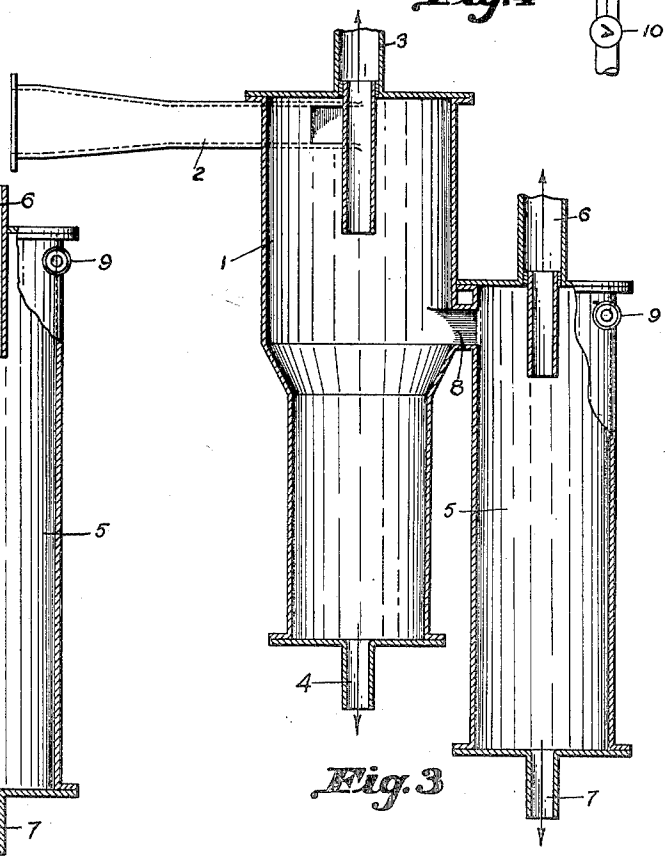


Fig. 3

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United States Patent Office 2,701,056 Patented Feb. 1, 1955

2,701,056

METHOD AND APPARATUS FOR CLASSIFYING AND CONCENTRATING MATERIALS

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Application September 1, 1951, Serial No. 244,747

4 Claims. (Cl. 209—144)

This invention relates to the treatment of finely divided solids for the purpose of classifying them on the basis of weight of the particles, as well as for the purpose of extracting from the mass of solid particles a desired concentrate.

The so-called "cyclone separators," involving the use of centrifugal force, have been long used for the treatment of finely divided solids and many variations have been suggested in the manner of constructing and using such separators.

The object of the present invention is to provide an improved method and apparatus, utilizing the essential operating principal of the cyclone separator, for the selective classification and/or concentration of the solids present in a fluid mass of finely divided material.

It is well recognized that the effect of centrifugal force, applied to a fluid mass of finely divided solids in a confined circular space, is to separate the solid particles into heavy and lighter fractions which may be withdrawn separately from the confined space. Normally the light fraction is discharged at the top and the heavy fraction at the bottom of the separator. Two or more such cyclone separators have been connected in series in order to repeat the separating effect of the centrifugal force.

It has now been found that greatly improved results are obtained when a substantial portion of the heavy fraction, which appears about the side wall of the cyclone separator, is withdrawn from the separator at about the mid point between the top and bottom of the separator and tangentially fed into a second similar separator, so that the heavy fraction relatively free from lighter weight solids is resubjected to the action of centrifugal force. To further enhance the desired separation of solid particles a fluid under pressure is tangentially fed into the second separator adjacent its top to dilute the thick material and facilitate its classification.

The withdrawal from the initial cyclone separator to the second separator should be substantially at the mid point between the top and bottom of the initial separator in order to utilize the improved method of the invention to best advantage and thus obtain the maximum beneficial capacity of the initial separator unit.

The invention will now be described with reference to the accompanying drawing in which

Figure 1 is an elevation view of two separators connected in series as shown.

Figure 2 is a sectional plan view of the arrangement shown in Figure 1.

Figure 3 is similar to Figure 1 with a variation of the inner contour of the initial separator and

Figure 4 is a sectional plan view of the arrangement of Figure 3.

In the drawing **1** is a cyclone separator having a tangential feed inlet **2**, an overflow outlet **3** and an underflow outlet **4**. As shown the confined separating zone is cylindrical in form, preferably with a top cylindrical section, as is commonly used. It is essential that the separating zone be circular in cross section through its length. It may be conical.

5 is a similar cyclone separator, preferably smaller in size, having an overflow outlet **6**, an underflow outlet **7** and a tangentially arranged feed inlet **8** connected as shown to separator **1** substantially half way between the top and bottom of the latter. A fluid inlet **9** is tangentially arranged at a point remote from inlet **8** and preferably at the opposite side of the separator **5**. Within this inlet is

a valve **10** and a pressure gauge, not shown, is preferably located between the valve and the separator.

In the form shown in Figure 3 the wall of separator **1** is inwardly inclined at the lower lip of the outlet **8** to change at this point the direction of downward flow of the descending fraction of material under treatment. The thus reduced diameter of the lower section of the separator increases the velocity of travel of the fluid mass under treatment.

Both separators are preferably rubber lined to avoid abrasion and undue interference with the spiral downward flow of the heavy fraction adjacent the wall.

In accordance with the method of the invention a fluid mass of finely divided solids is fed tangentially into the top of the initial separating zone under pressure, say 20 to 50 p. s. i., to form an outer descending fraction of relatively heavy material and an inner ascending fraction of lighter material in accordance with usual practice in the use of cyclone separators. A substantial portion of the outer heavy fraction is withdrawn as indicated and fed tangentially into the top of the second separating zone, while the remaining portion of the heavy outer fraction is allowed to proceed downwardly to permit increased removal therefrom of remaining light weight material which enters the axially ascending inner fraction of light material to be discharged as overflow. The heavy material is discharged as underflow.

The withdrawn portion of the heavy fraction as it enters the second separating zone is diluted by incoming fluid under pressure and the additional force imparted thereto causes it to travel circumferentially through the zone for further classification or concentration on the basis of the relative weight of the solids particles. The separated light weight material is discharged upwardly as overflow and the heavy remaining material downwardly as underflow.

As illustrative of the efficiency of the invention in comparison with that obtained by use of the normal cyclone separation, the following examples are given. In determining efficiencies, use is made of the standard formula

$$E=\frac{10000(c-f)(f-t)}{f(100-f)(c-t)}$$

where E is efficiency of classification, f per cent undersize in the feed, c per cent undersize in the overflow and t per cent undersize in the underflow.

(1) Separation of 10 micron material:
Single cyclone E=50.6%
The present device E=69.2%
(2) Separation of 74 micron material (200 mesh):
Single cyclone E=56.4%
The present device E=76.0%

The invention improves the efficiency of classification by substantially more than 30%, and with little or no increase in power consumption or time of operation. It is an easy matter to adjust operating conditions to meet the requirements of any desired specific size of material to be separated. The material to be processed may contain particles having a diameter of ¼ inch or more and the term "finely divided" as used herein is to be so interpreted.

It will be obvious to those skilled in the art that the invention may be applied in a variety of operations using an aqueous or gaseous fluidizing medium for the finely divided particles. Examples are, concentrating the gold or other metal values in ores into small fractions, removing fines of a specific size from the circuit of ore grinders and thus reducing the circulating load. In the latter the apparatus is inserted in series in the aqueous grinding circuit and the overflow fraction of sufficiently fine material is removed from the circulating load while the oversize material remains in the circuit.

It is now well recognized in the use of cyclone separators that the dimensions of the separating zone, inlets and outlets, volume of feed, feed pressure and the like are correlated. These known factors are equally applicable herein and form no part of the present invention.

I claim:

1. A method of separating solids from a fluid mass containing solids of varying particle size which com-

prises feeding the fluid mass under pressure tangentially into a confined separating zone, circular in cross section, to form an inner axially ascending portion of light weight material and an outer descending portion of heavier material, withdrawing heavy material at approximately the mid point between the top and bottom of the separating zone, discharging it tangentially into a second similar separating zone adjacent the top thereof, admitting fluid tangentially under pressure adajcent the top of said second zone to dilute said heavy material and withdrawing light weight material axially at the top of each separating zone and heavier material axially at the bottom of each zone.

2. Apparatus of the character described comprising a pair of separating chambers circular in cross section, an axially disposed discharge outlet at the top and bottom of each chamber, a tangentially disposed orifice substantially midway between the top and bottom of the first of said chambers arranged to discharge tangentially adjacent the top of the other of said chambers, means for admitting a fluid mass containing solids tangentially under pressure adjacent the top of the first of said chambers and means for admitting fluid tangentially under pressure adjacent the top of the other chamber.

3. Apparatus of the character described comprising first and second separating chambers circular in cross section, an axially disposed discharge outlet at the top and bottom of each chamber, a tangentially disposed orifice substantially midway between and in widely spaced relation to the top and bottom of said first chambers, said orifice communicating with the top portion only of said second chamber, and being arranged to discharge

tangentially thereinto, and means for admitting a fluid mass containing solids tangentially under pressure adjacent the top of said first chamber.

4. Apparatus of the character described comprising first and second separators, an axially disposed discharge outlet at the top and bottom of each separator, a tangentially arranged connection connecting said separators, said separators communicating in series through said connection, said connection being located at approximately the mid point between the bottom and top of the first separator and at the top portion of the second separator, a tangentially arranged feed inlet adjacent the top of said first separator, and a tangentially arranged fluid feed pipe adjacent the top of said second separator at a point substantially opposite said connection.

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