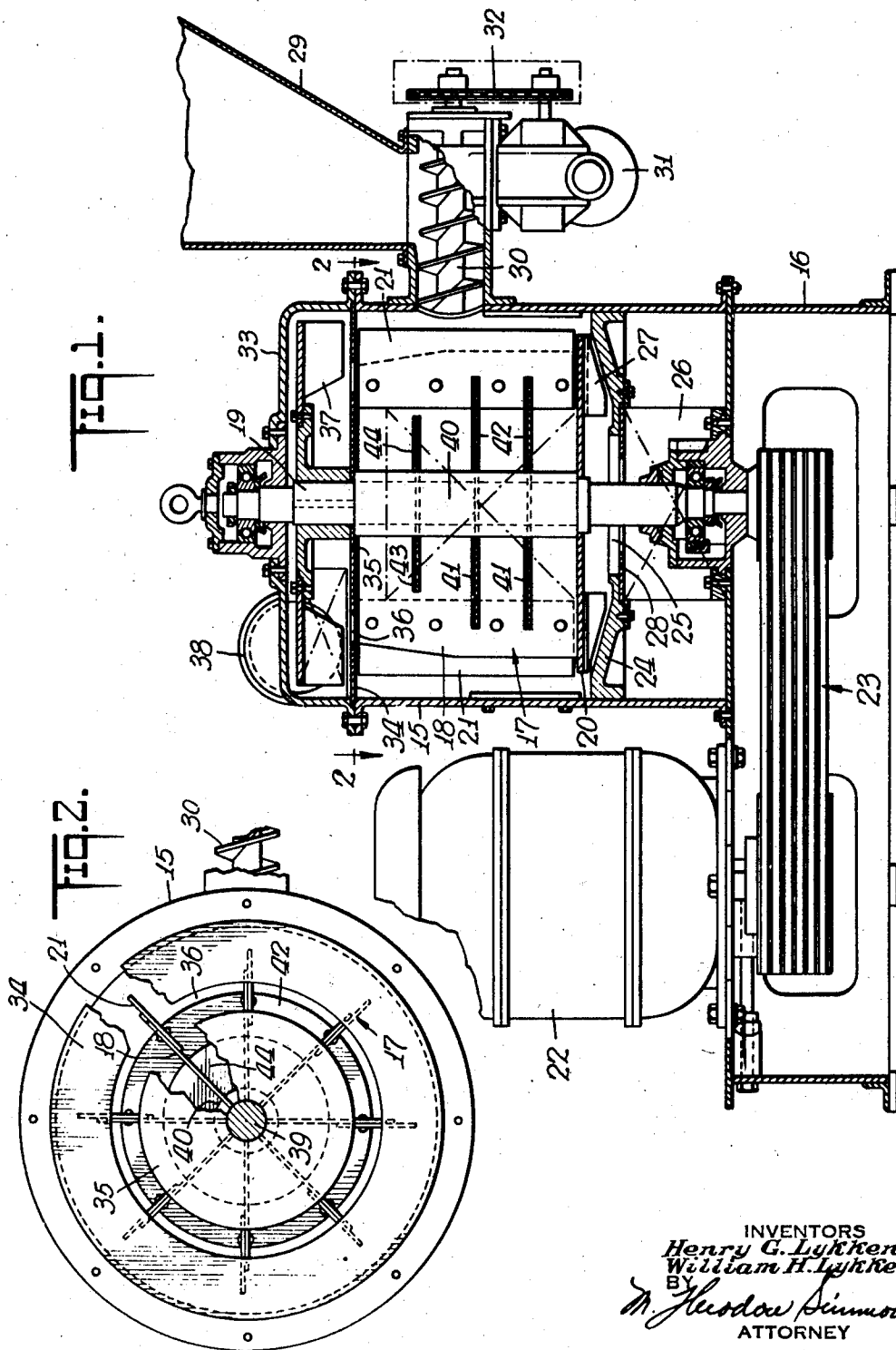


April 27, 1948.

H. G. LYKKEN ET AL
PULVERIZING AND CLASSIFYING MACHINE HAVING
A ROTOR COMPRISING SUPERIMPOSED SECTIONS
Filed April 28, 1943

2,440,285

3 Sheets-Sheet 1



INVENTORS
Henry G. Lykken
William H. Lykken
BY
M. Gordon Simmons
ATTORNEY

April 27, 1948.

H. G. LYKKEN ET AL
PULVERIZING AND CLASSIFYING MACHINE HAVING
A ROTOR COMPRISING SUPERIMPOSED SECTIONS
Filed April 28, 1943

2,440,285

3 Sheets-Sheet 2

FIG. 3.

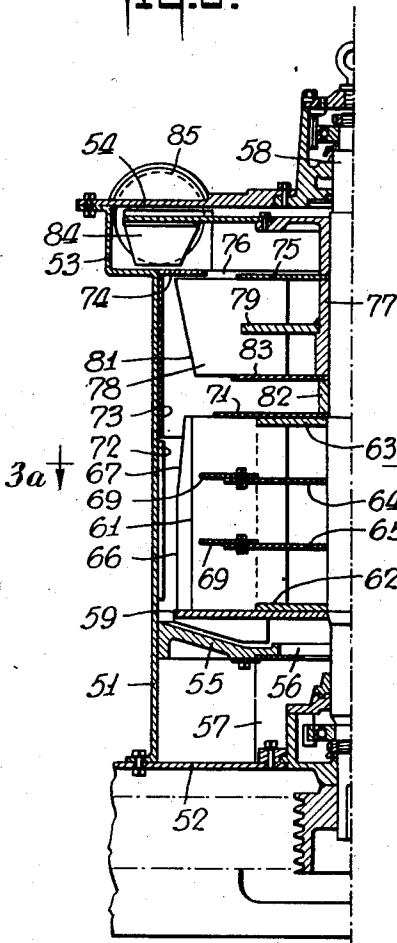


FIG. 4.

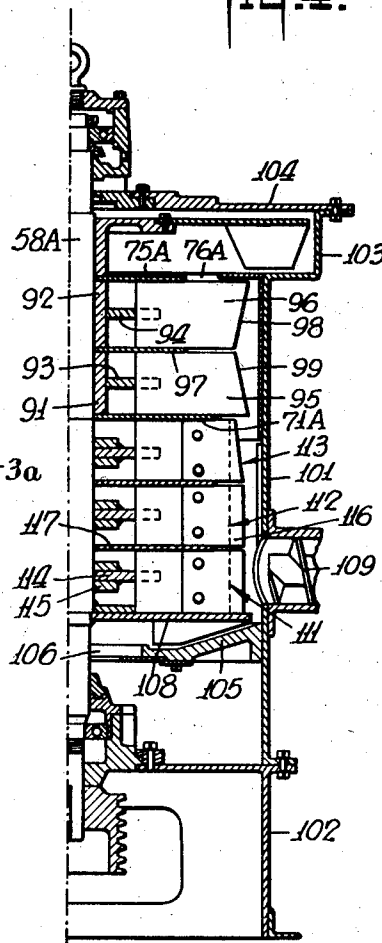
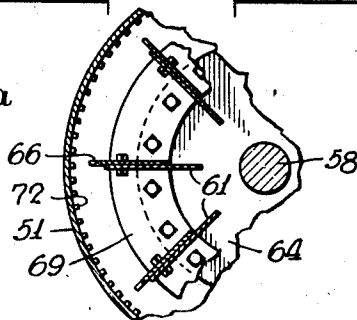


FIG. 3a.



INVENTORS
Henry G. Lykken
William H. Lykken
BY *Madore Simmons*
ATTORNEY

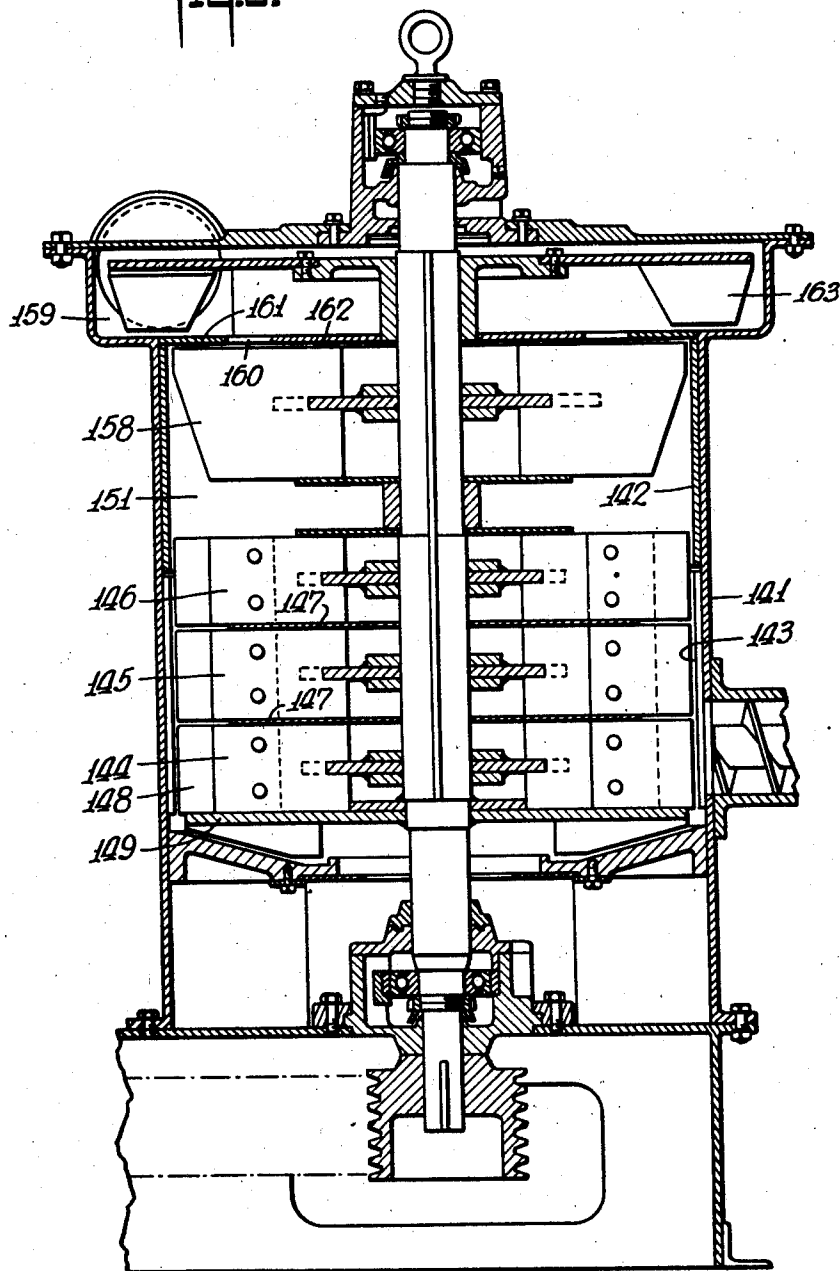
April 27, 1948.

H. G. LYKKEN ET AL
PULVERIZING AND CLASSIFYING MACHINE HAVING
A ROTOR COMPRISING SUPERIMPOSED SECTIONS
Filed April 28, 1943

2,440,285

3 Sheets-Sheet 3

Fig. 5.



INVENTORS
Henry G. Lykken
William H. Lykkens
BY *W. Theodore Simmons*
ATTORNEY

UNITED STATES PATENT OFFICE

2,440,285

PULVERIZING AND CLASSIFYING MACHINE
HAVING A ROTOR COMPRISING SUPER-
IMPOSED SECTIONSHenry G. Lykken and William H. Lykken,
Minneapolis, Minn.

Application April 28, 1943, Serial No. 484,898

9 Claims. (Cl. 241—56)

1

Our invention relates to apparatus for pulverizing and classifying friable materials, these functions being accomplished in separate machines or in one machine, as desired.

The application is a continuation-in-part of our application Serial No. 413,438, filed October 3, 1941, now Patent No. 2,380,321, issued July 10, 1945.

In most of the machines of these applications the friable materials are pulverized while suspended in a high speed vortex of air, or other gaseous medium, the centrifugal and other forces of which cause the particles of material to effect numerous collisions, rubbings, etc. with other particles until the material attains the particle size desired for the finished material. In the above application and in the forms shown in the present application, this high speed pulverizing vortex is produced by means of a rotor that is concentrically mounted in and spaced from the sides of a casing, the vortex occurring in the space around the rotor. Other pulverizing vortices are formed in the spaces between the radial blades of the rotor and adjacent the periphery of the rotor, one arrangement thereof being described in patent of Henry G. Lykken, No. 2,294,920, issued September 8, 1942. The air or other gas is admitted below the rotor, entering the vortex at the bottom, and the sufficiently pulverized material is carried out of the pulverizing zone into space at the top of the casing.

The mechanism is adaptable also to an arrangement where reduction in particle size is accomplished by a shearing action between the rotor blades and some stationary rib elements located in proximity thereto, but air still is used as the medium for lifting the sufficiently reduced material out of the pulverizing zone into the upper part of the casing.

In the machines of these applications, classification or selection of the properly pulverized material occurs in this upper part of the rotor chamber, the finished material being removed through an outlet above the rotor, which outlet is preferably annular, while the rejected oversize material returns to the pulverizing zone for further action thereon. The location and width of the annular outlet are adjustable, and the classification may be aided by and controlled by means of a rotor operating adjacent the annular outlet.

An outlet chamber located above the rotor may have a fan therein for withdrawing the air borne sufficiently pulverized material and delivering the same to a collection apparatus or place of use, but this fan need not be mounted on the same casing as the rotor mechanisms.

With these types of pulverizing and classifying machines, it has been found that much of the power requirement has been consumed because of a vertically circulating load, that is a

2

load of insufficiently pulverized material which would rise through and above the pulverizing chamber along with the sufficiently pulverized material and which would then fall back into the pulverizing zone for further reduction in particle size. It is one of the objects of this invention to practically eliminate this vertically circulating load, thereby reducing the power requirements and increasing the production capacity for a given size of apparatus.

It is another object of this invention to provide a pulverizing mechanism with means by which a minimum of oversize particles enters the classification chamber thereby reducing the load upon the centrifugally acting classifier mechanism to eliminate oversize particles.

It is another object of this invention to provide a horizontally sectionalized rotor in apparatus of the above indicated character, which sectioning may occur in either or both the pulverizing and the classifying rotors.

In machines of the above character it has also been found that the nature of the material being pulverized, including such factors as the flakiness of the material, the shape of the particle, its tendency to conglomerate after being reduced in particle size, the specific gravity of the material, etc., all materially affect the pulverizing, classifying and collecting operations so that adapting a mechanism of a given size to produce particles of a selected size in one material will not give the same results or have the same output capacity with materials of different characteristics. The apparatus of this case contemplates readily variable structural elements whereby mechanisms may be made in standard forms and sizes that are assembled easily into the complete apparatus, and, if desired, may be just as readily modified by the customer or at the customer's place of business.

It is a further object of this invention to provide arrangements of horizontal, superimposed, rotor sections that may be spaced on centers varying from 1" to 4", and for the use of two or three or more such sections in order to achieve the result of keeping the material in the pulverizing zone until it is sufficiently reduced in particle size.

Again, the variable factors or characteristics of the materials being pulverized necessitate considerably different treatments in the classification zone so as to eliminate any oversize material that reaches that zone, returning the same to be further pulverized. At times this is accomplished by interposing a single rotor operating close to the outlet. At other times it is desirable to provide an annular space between the pulverizing and classifying rotors. At still other times it is necessary to widely vary the numbers of the radial blades in the classifying and pulverizing rotors.

Further objects of our invention are to provide for each of the foregoing contingencies.

Other and further objects of this invention will be understood from the accompanying drawings, in which several different embodiments of suitable mechanisms are set forth by way of example of the principles involved. In the drawings:

Figure 1 is a vertical central section of a pulverizing and classifying machine constructed according to our invention.

Fig. 2 is a cross section on the line 2—2 of Fig. 1, parts being broken away to facilitate illustration.

Fig. 3 is a fragmentary vertical section of a modified form of our invention showing the use of separated pulverizing and classifying rotors on the same rotor shaft.

Fig. 4 is a fragmentary vertical section of a further modified form illustrating the use of sectionalized pulverizing and classifying rotors.

Fig. 5 is a vertical sectional view of a modified construction, and illustrating the adaptation to pulverizing by a shearing action.

Referring to Figs. 1 and 2, a cylindrical casing 15, mounted upon a base 16 houses a rotor 17 having radial blades 18 carried by a vertical shaft 19 that is centrally located in the casing 15. The rotor also has a closed bottom disc 20 of less diameter than the casing 15, and the blades 18 have extension plates 21 bolted thereto, and extending in this case, substantially to the edge of the rotor disc 20. It will be noted that the blades 18 and plates 21 extend vertically substantially to the top of the casing, and a pulverizing vortex of air and suspended material is set up and maintained in the annular space around the rotor. The rotor shaft 19 is driven from an electric motor 22 that is mounted upon the base 16, through the belt and pulley arrangement indicated at 23. The pulleys may be replaced by other pulleys of different sizes so as to operate the rotor shaft at different speeds, as desired.

Material to be pulverized may be fed into the rotor chamber from a hopper 29 by means of a feed screw device 30 which is driven at a controlled speed by the motor 31 through a chain and sprocket arrangement as indicated at 32. By simply replacing these sprockets with others of different size, the rate of feed of the material may be varied, and of course this result may be gotten by any other well known motor speed control applied to the motor 31.

The casing 15 is closed below the rotor disc 20 by means of dish shaped bottom plate 24 having a central opening 25 therein. Air is admitted into the space below the plate 24 through the opening 26 in the side of the casing 15, which air passes upwardly through the opening 25, outwardly beneath the rotor disc 20 and enters the annular space between the rotor 17 and the casing 15. The distribution of this air in that annular space is aided by the fan blades 27 mounted on the bottom of the rotor disc 20, and the amount of air admitted into the rotor chamber may be controlled by means of a slidable shutter indicated at 28.

The casing 15 is closed at its top by means of a hollow cover 33, flanges on the casing and cover being bolted together as indicated. The space in the cover is separated from the rotor chamber by means of an outer stationary ring-shaped plate 34 and an inner rotor-carried disc 35 of such sizes respectively to provide the annular opening 36, which forms an outlet from the rotor chamber into the hollow cover, which may

be termed the outlet chamber. The plate and disc are readily removable and replaceable, and the width of the plate 34 and the diameter of the cooperating disc 35 may be varied to provide two control factors of the size of the particle delivered from the apparatus and its output capacity, viz., (1) the width of the annular outlet 36 and its radial location; according to present experience the annular outlet 36 may be located radially from its axis anywhere in the area from one-half to two-thirds of the diameter of the rotor, and (2) the width of the annular opening may vary between one and two and one-half inches. These variable conditions and the reasons therefor are fully discussed in our co-pending application Serial No. 367,314, filed November 27, 1940, now Patent 2,392,331, issued January 8, 1946, and are not claimed herein except in conjunction with the other features comprising the subject matter of the present invention.

The shaft 19 has a fan 37 mounted thereon in the outlet chamber 33, and an outlet 38 from the chamber 33 leads to any suitable collection device or to the place of use. The number of blades on the fan 37 and the size thereof will vary in accordance with the delivered particle size, the volume of output, etc., as is well understood.

The whole rotor construction is that of a closed end rotor, which produces a high speed vortex in the annular space between the rotor and the casing. As explained in the patent of Henry G. Lykken, No. 2,294,920, issued September 8, 1942, by an appropriate spacing of the blades 18 around the rotor and relating the same to the width of the annular space, small high speed vortices are produced between each pair of rotor blades, which vortices are fed from the annular vortex, and carry on the further reduction of the material being acted upon. As the material is pulverized it rises in the rotor chamber toward the outlet 36, and in the upper part of the chamber the rotor functions to classify the material by eliminating oversize particles into the annular space around the rotor, whence they fall by gravity into the pulverization zone for further reduction in particle size.

It has been found that the upward passage of air and material was lifting large quantities of insufficiently pulverized material into the classification zone which material would have to be returned to the lower or pulverizing zone of the rotor.

In the present described form of apparatus, the rotor blades 18 are mounted on the hub 40 which is keyed to the shaft 19, and these blades, together with the plates 21 thereon, are provided with one or more horizontal slots 41 for the reception of horizontal discs 42. These slots and discs, in the present form, are of less diameter than the bottom rotor disc 20 and are spaced vertically therefrom and from each other so as to divide the lower end of the rotor 17 into a plurality of sections, arranged according to the pulverization requirements for the particular material being acted upon. According to our present experience these discs may be spaced vertically on centers varying from one to four inches. At times, one such intermediate disc is sufficient, while at other times two or more such discs are needed. The effect of these intermediate discs 42 is to provide concentrated closed end rotor effects in the lower parts of the rotor chamber, thereby increasing the intensity of the pulverizing vortex action and providing several stages thereof. Furthermore, by interposing the discs 42 as

5

indicated, the upward passage of substantial quantities of oversize material is very greatly reduced, and while the upward current of air is sufficient to carry off the sufficiently pulverized material as rapidly as it is produced, the great bulk of the oversize material is retained in the lower portion or pulverizing zones of the rotor chamber, and more rapid pulverization also is obtained by this construction.

The elimination of the stray particles of oversize material occurs in the upper part of the rotor chamber where the material in passing to the annular outlet 36 is subjected to the centrifugal action of the rotor operating immediately adjacent that outlet. At times, with certain materials, there is a tendency for too much of the material that is removed from the pulverizing zone to move in toward the hub 40 of the rotor and rise therealong so that large quantities of material are moved radially outward past the annular outlet 36 as the classification action proceeds. This affords an opportunity for stray oversize particles to be mingled with the sufficiently pulverized material which passes through the outlet into chamber 33. To overcome this condition, the rotor blades 18 may be provided also with radial slots 43 in which is located a horizontal disc 44.

Usually, this disc need not be as large in diameter as the discs 42 but as will be understood the material is subjected to a preliminary and a final centrifugal action in the classification action and these centrifugal actions are distributed over a substantial portion of the height of the rotor thereby giving full opportunity for removal of the oversize material.

The subject matter of these several intermediate discs is described in the aforesaid application Ser. No. 413,438, now continued in this application.

Much of the description, principles and operation of the machine shown in Figs. 1 and 2 applies to the machines in the other figures of the drawing and as far as practicable we will avoid repetition of as many of those details as possible in the following specification. However, in the machine of Fig. 5 pulverization is obtained by a shearing action between rotating and stationary elements but as in all of the machines of this application, classification is effected by means of centrifugal vortical action, as is the collection of the finished material.

Fig. 3 illustrates another construction adapted for a wide variety of materials, and provided with other arrangements allowing for a built-up, widely variable construction. The cylindrical casing 51 is mounted upon the hollow base 52, similar to the construction illustrated in Fig. 1. In this case the casing 51 has portion 53 of enlarged diameter at the top thereof, and the casing is closed at the top by a cover 54. Spaced above the base 52, the cylinder has a dish shaped annular bottom 55 and air enters the rotor chamber through the central opening 56 therein, the air being admitted into the casing through the side opening 57 therein.

A rotor shaft 58 is centrally mounted in the casing 51 to rotate in bearings supported by the cover and base respectively, as shown. The rotor shaft has mounted thereon a bottom rotor disc 59 which extends outwardly toward but is spaced from the casing 51 to provide space for an annular pulverizing vortex. The pulverizing rotor comprises a plurality of fixed radial blades 61 which are carried by upper and lower supplementary

6

discs 62 and 63. Spaced between these supplementary discs are intermediate discs 64 and 65 dividing the rotor into three sections. As explained in connection with Fig. 1, the sections of the rotor may be of various selected heights. The rotor blades 61 have removable plates 66 mounted thereon which extend the blades radially outwardly any desired distance, shown in this case to be nearly to the edge of the bottom disc 59. The upper ends of these radial plates 66 may be tapered inwardly, as indicated at 67 in Fig. 3, or similarly tapered outwardly, the difference in taper being chosen in accordance with the nature of the material and of the particle size desired to be delivered from the machine. This taper may be anywhere between the 12° inward taper shown at 67 and a 12° outward taper. For most materials the inward taper 67, producing the less violent vortex action, will be used for coarse, non-flaky, products and the outward taper, producing the more intense vortex, will be used for final, flakier, materials.

The intermediate discs 64 and 65 are a minimum diameter, but may have attached thereto segments 69 which fit between each pair of blades and are bolted to the discs 64 and 65 to extend horizontally therefrom whatever distance is necessary for the desired action on the particular material. Generally, materials of high specific gravity require a more intense pulverizing vortex in the space between the rotor and the casing 51. That is to say, the nearer the outer edges of the plates 69 extend to the outer rotor diameter defined by the edges of the plates 66, the more intense will be the centrifugal action in the vortex around the rotor, and the less will be the vertical lift of the air and suspended material in the vortex, and such lift will occur in stages so that as a practical matter, only finished material will pass from the pulverizing zone, defined by the pulverizing rotor. By means of these interchangeable blade plates 66 and disc segments 69, the grinding load can be controlled for any given specific gravity of material being pulverized, and for any given fineness of particle to be delivered, within the capacity of the particular size of apparatus. At the top, the pulverizing rotor is closed by a supplementary disc 71 which overlies the upper rotor disc 63 and extends radially outwardly over the top of the rotor blades 61. Preferably this plate 71 does not extend the full width of the discs 64 or 65 with their segments 69, although it may do so.

The casing 51 may be provided with an inner liner 72 which may or may not have ribs thereon for assisting in the pulverizing action, which liner extends substantially to the top of the pulverizing rotor. Above the liner 72 the casing may have an additional inner liner 73 which, however, is preferably smooth since this upper part of the casing 51 is the classification zone. The casing 51 is separated from the enlarged chamber 53 by means of a stationary annular ring 74 and a plate 75 carried by the rotor, the two cooperating to form annular opening 76 constituting the outlet from the pulverizing and classifying chamber into the enlarged outlet chamber 53, similar to the outlet 36 of Fig. 1.

The shaft 58 has a rotor mounted thereon which operates adjacent the annular outlet 76, which rotor comprises the hub 77, a plurality of radial blades 78 carried by a horizontal disc 79 which is fastened to the hub 77. The outer edge of each blade may be tapered upwardly and outwardly as indicated at 81, or the rotor may be

7

inverted so that the taper is in the opposite direction. The classification rotor is spaced from the pulverizing rotor by means of a spacing collar 82 mounted on the rotor shaft 58. The bottom of the classification rotor is partially closed by means of a disc 83 which extends horizontally from the rotor shaft a distance which will vary with the material being pulverized but in general there will be sufficient room for the pulverized material to enter the rotor blades 78 at the bottom thereof so that the particles are subjected to the centrifugal force of the pulverizing rotor as the air borne pulverized material rises toward the annular outlet 76. A fan 84 mounted in the outlet chamber 53 aids in withdrawing the material from the pulverizing and classifying chamber through the outlet 76 and delivering the sufficiently pulverized material from the machine through the outlet 85.

In the operation of the mechanism of Fig. 3, the rotor is set into operation, air is admitted beneath the rotor through the openings 56 and 57, the air entering the vortex at the bottom thereof around the edge of the bottom plate 59 of the rotor. Material to be pulverized may be fed to the pulverizer by means similar to that shown in Fig. 1; and the rotor shaft 58 is set into operation. The rotor creates the pulverizing vortex in the space therearound, the material progressing toward the top of the casing and moving from stage to stage of the sectionalized pulverizing rotor. The sufficiently pulverized material expands into the free space above the pulverizing rotor which is defined by the collar 82 but the vortex set up by the pulverizing and classifying rotors continues in this space, for the segregation of the oversize. Material enters the classifier rotor which throws out any remaining oversize material while the sufficiently pulverized material is delivered through the annular outlet 76. The free space is usually from one to two inches in height.

With the pulverizing rotor having the blades tapered in the direction shown in full lines in this Fig. 3, the rotor is arranged for classification of very fine materials. With the rotor turned upside down, so that the inclination of the rotor blades is inwardly from the bottom, the rotor is arranged for the handling of the coarser particle sizes. Tapers intermediate these limits may be used as dictated by the circumstances of the use of the machine.

It will be noted that the pulverizing rotor is an assembled unit suitably keyed to the shaft 58, the plate 71 and collar 82 fit loosely about the shaft, and the classifier rotor is an assembled unit keyed to the shaft 58. Furthermore, the ring 74 and plate 75 are merely set in place, and the hub of the fan 84 is keyed to the shaft. Thus the units may be readily lifted out and replaced for repair or for other operations, and at the factory the machine is made up of assembled units.

It should be noted in connection with Figs. 3 and 4, as well as in connection with the other mechanisms shown in this application, that the number of radial blades of the classifier rotor can be different from the number of blades of the pulverizing rotor, and frequently the classifier rotor has a greater number of blades. In some cases the number of blades of the classifier rotor are increased to such an extent that there is substantially no intra-blade vortical action and the classification occurs in a vortex around the classifier rotor that is substantially free from

8

undulations produced by the rotor blades. The sufficiently pulverized material must still enter between the rotor blades to reach the annular outlet, and thus moves against the centrifugal action of the blades.

These same principles may be applied to the pulverizing rotor by having the same built up of a plurality of interchangeable sections, and the number of blades in each section may be different or the same as the number in other sections. Referring to Fig. 4, the cylindrical casing 101 is mounted upon the hollow base 102, and is surmounted by an enlarged outlet chamber 103 which is closed at the top by the cover 104, similar to the constructions previously described. The casing has an annular dish shaped bottom 105 with a central opening 106 therein for the admission of air into the rotor chamber thereabove. The rotor shaft has a bottom disc 108 thereon.

The pulverizing rotor comprises a plurality of prefabricated sections, three such sections being illustrated at 111, 112 and 113, which are alike in construction except the number of radial blades in each may be different. Each rotor section comprises a hub 114, keyed to the rotor shaft, and a horizontal portion of which carries radial blades 115 to each of which is bolted an extension plate 116 extending radially outwardly but spaced from the casing 101. Each rotor section is separated from the next adjacent section by means of an intermediate plate 117, the pulverizing rotor being built up by mounting a rotor section on the hub shaft, then an intermediate disc and another rotor section and another intermediate disc and so on, until the desired height of pulverizing rotor is obtained.

The lowermost section of the pulverizing rotor may be provided, for example, with twelve or sixteen radial blades to maintain a pulverizing vortex externally of the rotor of sufficient intensity to break up quickly and effectively the coarse material fed into the machine and with little or no intra-blade vortex action. The succeeding sections of the pulverizing rotor can have a less number of blades, eight or twelve, to handle a greater quantity of finer material in intra-blade vortices. This blade arrangement also can be progressive, as with sixteen in the lowermost section 111, twelve in the intermediate section 112, and eight blades in the upper section 113.

Aside from the difference in the pulverizing rotor heretofore pointed out in connection with Fig. 4, over the construction shown in Fig. 3, the machine of Fig. 4 illustrates a modified construction in the classification portion of the rotor chamber. In Fig. 4 there is no free space between the pulverizing and classifying rotors such as that defined by the collar 82 in Fig. 3. Instead, the classification rotor in Fig. 4 is made of two sections, comprising respectively hubs 91 and 92, mounted on the rotor shaft 58, discs 93 and 94 carried thereby, and a plurality of radial blades 95 and 96 respectively. The two sections of the classifier rotor are separated by the disc 97 while the end discs 71a and 75a, similar to plates 71 and 75 of Fig. 3, close the outer ends of the classifier rotor sections. Thus, as explained in connection with the sectionalized pulverizer rotor, the particles also are subjected to stage by stage concentrated vortical actions during classification. To aid in the control of the particle size delivered through the annular outlet 76a, the outer edges of the radial blades 95 and 96 may be tapered as indicated at 98 and

99, or as pointed out in connection with Fig. 3, either or both of these rotor sections may be inverted so that the tapers thereof extend in the opposite directions from those illustrated.

Fig. 5 illustrates two modified arrangements of the construction described in detail in connection with Fig. 4. Since the method of building up the pulverizing rotor of superimposed sections and separating discs in the same, such matters will not be described in connection with Fig. 5. The differences over Fig. 4 are two in number: (1) the machine of Fig. 5 is intended for operation upon fibrous materials, such as grain, saw dust, vermiculite, etc., pulverization being accomplished by a shearing action, and (2) the classifier rotor is of greater height than the individual sections of the pulverizing rotor. Varying the height of the classifier rotor serves as an additional means for control of particle size of material delivered from the machine. For fine particles and more precise classification a greater height is used than for coarser or less precise classification. It should be noted that this additional control factor in the classifier is useful regardless of the method of pulverization, and can be applied to any of the machines described.

Referring to Fig. 5, the casing 141 has mounted on the inner surface thereof a lining 142 and a plurality of equi-distant, inwardly projecting ribs 143 extending substantially the full height of the pulverizing rotor which, in this case, comprises the sections 144, 145 and 146, that may or may not be separated by the intermediate discs 147. However, it will be noted that in this Fig. 5 the radial plates 148 of the rotor blades extend outwardly to operate with a very slight clearance between the plates and the ribs 143. In the construction of Fig. 5 it is not intended that there will be any vortex action around the rotor, although air is admitted around the edge of the lowermost rotor disc 149 for the other purposes of this machine. In the case of the fibrous and some other materials, we have found that the reduction in particle size is accomplished best by a shearing of the material between the edges of the rotor blade plates 148 and the stationary ribs 143. Frequently, in this construction, the number of rotor blades is substantially increased, being spaced on two inch centers around the periphery of the rotor, and the clearance between plates and ribs being of the order of one-eighth to one-quarter inches.

The finished material passes from the upper rotor section 146 into free space 151 beneath the classifier rotor section 152 which may be similar in construction and functioning to those heretofore described in connection with Figs. 1 to 4, or as indicated above, the height of the single rotor section may be varied to control fineness of delivered particle, Fig. 5 showing a classifier rotor greater in height than any of the sections of the pulverizing rotor. The sufficiently reduced material passes from the rotor chamber 141 into the outlet chamber 159 through the annular outlet 160 that is formed by the ring 161 and the rotor plate 162 as heretofore described. The fan 163 functions in the outlet chamber 159 the same as in the previous embodiments.

In the foregoing specification various embodiments of mechanisms to accomplish the objects of our invention have been disclosed. It will be apparent that other modifications and combinations may be made within the spirit and scope of our inventions, and such modifications are intended to be covered by the appended claims.

We claim:

1. A pulverizing and classifying machine comprising a cylindrical casing, means for supplying air and material to be pulverized to said casing at regulated rates, a bottom in said casing having an opening therein for the admission of air, a cooperating ring and disc at the upper end of the casing spaced from each other to define an annular outlet, a closed end rotor of less diameter than the casing and having a plurality of radial blades extending substantially between said bottom and said outlet and arranged to set up a vortex of air suspended material in the space around said rotor, a plurality of transverse discs dividing said rotor into a plurality of closed end rotor sections, the rotor operating to pulverize material in the vortex around the lower portions thereof and to classify the material in the portion adjacent said outlet, and fan means for withdrawing sufficiently pulverized material through said outlet.

2. A pulverizing and classifying machine comprising a cylindrical casing, means for supplying air and material to be pulverized to said casing at regulated rates, a bottom in said casing having an opening therein for the admission of air, a cooperating ring and disc at the upper end of the casing spaced from each other to define an annular outlet, a closed end rotor of less diameter than the casing and having a plurality of radial blades extending substantially between said bottom and said outlet and arranged to set up a vortex of air suspended material in the space around said rotor and also arranged to set up vortices of air suspended material in the spaces between the blades of said rotor, a plurality of transverse discs dividing said rotor into a plurality of closed end rotor sections, the rotor operating to pulverize material in the vortex around the lower portions thereof and to classify the material in the portion adjacent the outlet, and fan means for withdrawing sufficiently pulverized material through said outlet.

3. A pulverizing and classifying machine comprising a cylindrical casing, means for supplying air and material to be pulverized to said casing at regulated rates, a bottom in said casing having an opening therein for the admission of air, an outlet at one end of said casing for the pulverized material, and a plurality of superimposed closed end rotor sections of less diameter than the casing and operating adjacent said bottom to cause pulverization of said material, each of said rotor sections having a plurality of radial blades with top and bottom discs defining each section, and segments fitting between each pair of blades and bolted to certain of said discs to form outer extensions thereof to alter the pulverizing effect of the section defined thereby.

4. A pulverizing and classifying machine comprising a cylindrical casing means for supplying air and material to be pulverized to said casing at regulated rates, a bottom in said casing having an opening therein for the admission of air, an outlet at one end of said casing for the pulverized material, and a plurality of superimposed closed end rotor sections of less diameter than the casing and operating adjacent said bottom to cause pulverization of said material, each of said rotor sections having a plurality of radial blades, top and bottom discs for each section, and means to alter the pulverizing effect of each section, such means comprising outer extension plates bolted to the blades, and segments fitting between each

11

pair of blades and bolted to said discs to form outer extensions thereof.

5. A pulverizing and classifying machine comprising a cylindrical casing, means for supplying air and material to be pulverized to said casing at regulated rates, a bottom in said casing having an opening therein for the admission of air, a cooperating ring and disc at the upper end of the casing spaced from each other to define an annular outlet for sufficiently pulverized material, the outlet being radially outward of the hub of the adjacent rotor, a rotor of less diameter than the casing and having a plurality of superimposed sections each having a plurality of radial blades, the sections of the rotor causing pulverization of the material, other rotor means operated adjacent the outlet and arranged to receive and to classify the pulverized material by centrifugal action, the pulverizing and classifying rotors being separated by a free space which receives the pulverized material from the pulverizing rotor, and from which space the classifying rotor receives the pulverized material.

6. A pulverizing and classifying machine comprising a cylindrical casing, means for supplying air and material to be pulverized to said casing at regulated rates, a bottom in said casing having an opening therein for the admission of air, a cooperating ring and disc at the upper end of the casing spaced from each other to define an annular outlet for sufficiently pulverized material, the outlet being radially outward of the hub of the adjacent rotor, a rotor of less diameter than the casing and having a plurality of superimposed sections each having a plurality of radial blades arranged to provide a pulverizing vortex of air suspended material in the space around the rotor, other rotor means operated adjacent the outlet and arranged to provide a vortex of air suspended pulverized material in the space around said other rotor means, the pulverizing and classifying rotors being separated by a free space which receives the pulverized material from the pulverizing vortex and from which space the classifying rotor receives the pulverized material, the space between the rotors being such that the rotors set up a classifying vortex of air suspended material in said free space.

7. A pulverizing and classifying machine comprising a cylindrical casing, means for supplying air and material to be pulverized to said casing at regulated rates, a bottom in said casing having an opening therein for the admission of air, a cooperating ring and disc at the upper end of the casing spaced from each other to define an annular outlet for sufficiently pulverized material, the outlet being radially outward of the hub of the adjacent rotor, a rotor of less diameter than the casing and having a plurality of superimposed sections each having a plurality of radial blades, the sections of the rotor causing pulverization of the material, other rotor means operated adjacent the outlet and comprising a plurality of superimposed sections arranged to receive successively and to classify the pulverized

12

material by centrifugal actions and each having a plurality of radial blades, and fan means for withdrawing pulverized material through said outlet.

8. A pulverizing and classifying machine comprising a cylindrical casing, means for supplying air and material to be pulverized to said casing at regulated rates, a rotary shaft centrally mounted in said casing, rotor means for causing pulverization of the material, said rotor means comprising a plurality of closed end sections detachably secured to said shaft, each comprising a hub member carrying a plurality of radial blades, a central disc between and defining each of said rotor sections, and the central disc forming the upper end of said rotor sections being of less diameter than the intermediate central discs, other rotor means for classifying the pulverized material by centrifugal action, and an outlet for the sufficiently pulverized material.

9. A material pulverizing and classifying machine comprising a cylindrical casing, means for supplying air and the material to be pulverized to said casing at regulated rates, rotor means of less diameter than the casing and comprising a plurality of superimposed transverse sections, each constructed and operating to produce a pulverizing vortex of air and suspended material in the space around the sections, a cooperating center disc and ring-shaped baffle mounted near one end of the casing and spaced apart to define an annular outlet the inner edge of which is spaced intermediate the hub and the diameter of an adjacent rotor means, other rotor means located at one side of and adjacent said outlet, the same also being of less diameter than the casing and constructed and operating to maintain a classifying vortex of air and suspended material in the space around the same, and fan means for withdrawing the sufficiently pulverized material from the pulverizing vortex to the classifying vortex and through the outlet.

HENRY G. LYKKEN.
WILLIAM H. LYKKEN.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
812,122	Fassett	Feb. 6, 1906
1,955,960	Hirsch	Apr. 24, 1934
2,294,920	Lykken	Sept. 8, 1942
2,294,921	Lykken	Sept. 8, 1942
2,304,264	Lykken	Dec. 8, 1942
2,200,822	Crites	May 14, 1940
1,756,253	Lykken	Apr. 29, 1930
2,055,484	Fraser	Sept. 29, 1936
2,286,987	Sturtevant	June 16, 1942
1,882,329	Kreisinger	Oct. 11, 1932
48,226	Whepley et al.	June 13, 1865
2,152,876	Crites	Apr. 4, 1939
2,169,680	Crites	Aug. 15, 1939