United States Patent

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[31] **43/77892**

[54] **PULVERIZER**
5 Claims, 4 Drawing Figs.

[52] **U.S. Cl.** **241/43,** 241/56
[51] **Int. Cl.** **B02c 13/288,** B02c 13/12
[50] **Field of Search** 241/55, 56, 43, 45

[56] **References Cited**

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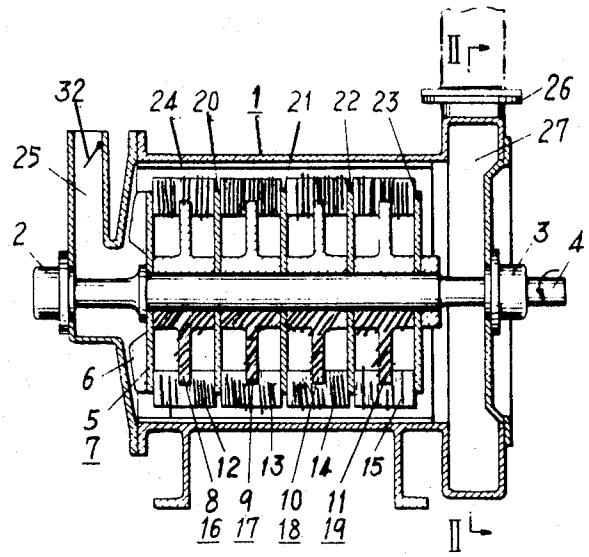
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ABSTRACT: A pulverizer comprising an outer cylindrical casing, a plurality of rotors rotatable concentrically within said casing, said rotors having a number of radially extending blades, and at the downstream end of said rotors a whirl chamber whose entrance diameter is same with the inner diameter of said outer casing; whereby material pulverized by said rotors in the casing is directly carried to said whirl-shaped chamber. This chamber is devoid of additional impellers or obstructions, so that the pulverized material is free to outwardly whirl as it leaves the vicinity of the rotors.



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Fig. 1.

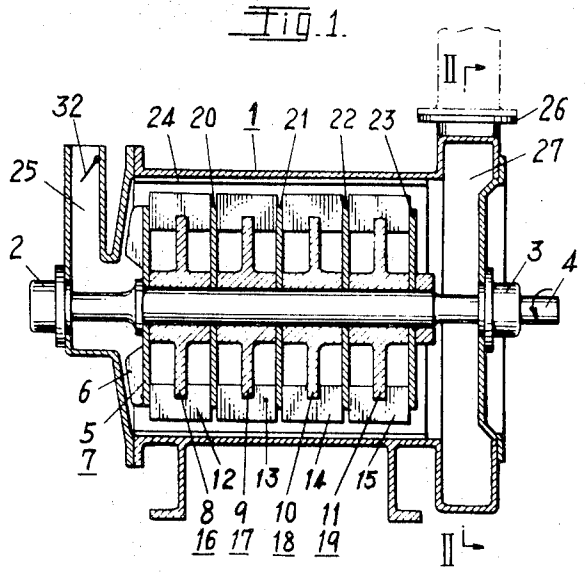
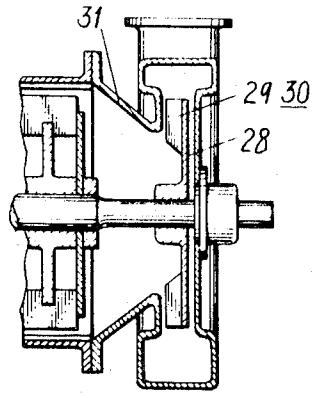


Fig. 3.



PRIOR ART

Fig. 2.

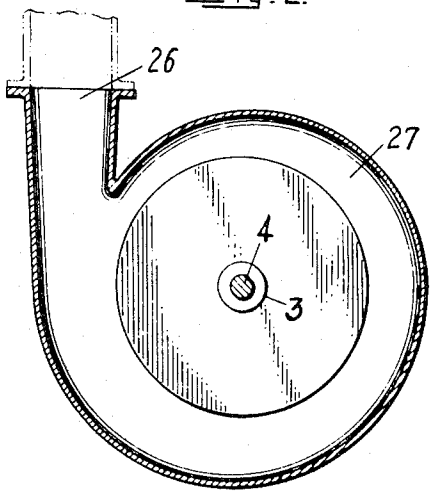
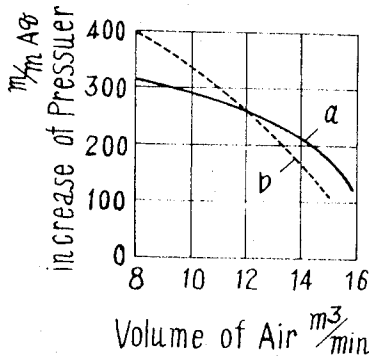


Fig. 4.



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PULVERIZER

This invention relates to an improved pulverizer suitable for pulverizing synthetic material, foodstuff and chemical products. The pulverizer is also suitable for decomposing asbestos, asbestos product scraps, lumber, leather and other fibrous materials.

The pulverizer of the present invention comprises a cylindrical casing, a shaft rotatable with high speed around the centerline of said casing, an impeller at one end of said rotatable shaft for feeding air and distributing material, a plurality of rotors each consisting of a disc and having at its periphery a number of radially extending blades, the radial extent of the blades being slightly less than the inner diameter of said ridge so as to leave a slight clearance between the tip of said blade and the inner wall of said casing, and a plurality of discs fixed to said rotary shaft and arranged in alternate and axially abutting relation to said rotors. By action of the whirling airstream produced by the rotation of said rotors, material fed into the apparatus is pulverized into particles and with said air stream the material is carried from the first rotor to the adjacent rotors in the casing and finally discharged from the casing.

While this type of pulverizer cools the inside of the apparatus and material to be pulverized with a volume of air, it can pulverize even such elastic and extendable material sensitive to heat as synthetic resin, which material has been considered as impossible to be pulverized with a hammer crusher or toothed disc crusher due to its fusible nature.

Heretofore, in pulverizing such material as polyethelane of which fine power is increasingly in demand for purposes such as fluidized bed coating and electrostatic spray painting, there was the tendency to produce granules too rough for said use or which were mingled with several particles bound together or formed with an undesirable shape as a film.

One object of the present invention is to furnish a pulverizer that is able to produce fine power suitable for use in fluidized bed coating and electrostatic spray painting.

Another object of this invention is to furnish a pulverizer having high pulverizing capacity and accomplish an efficient work with smaller power consumption, yet formed of a simple construction low in cost.

Other advantages and objects of this invention will be more apparent as the description proceeds with reference to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a longitudinal sectional view of a pulverizer constructed according to the present invention;

FIG. 2 is a sectional view taken along the line II—II of FIG. 1;

FIG. 3 is a longitudinal sectional view of a part of a prior art apparatus; and

FIG. 4 is a diagram showing the relation between the pressure rise and air volume in the pulverizer constrasting the present invention to the conventional apparatus.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Now referring to the drawings, an outer cylindrical casing 1 has at the opposite ends shaft bearing boxes 2 and 3 respectively supporting a rotary shaft 4 rotatable with high speed about the centerline of said casing 1. The shaft 4 is provided with a disc 5 having on its outer face a number of radially extending blades 6 to form an impeller 7 for feeding and distributing air and material, discs 8, 9, 10 and 11, each having on its outer periphery a number of blades 12, 13, 14 and 15, respectively, extending parallel to said centerline. Thus, there is formed rotors 16, 17, 18 and 19 respectively. Fixed on said shaft alternately and abuttingly thereto are thin discs 20, 21, 22 and 23, so that the rotors and discs are arranged in an order as shown in FIG. 1. There is a clearance of about several millimeters between the outer diameter of rotors 16, 17, 18, 19 and inner wall, that is, between the tip of blades 12, 13, 14, 15 and the inner wall of the cylindrical casing 1 having a number of ridges 24 extending parallel to said rotary shaft 4. The outer diameter of discs 20, 21, 22, 23 is smaller than that of rotors 16, 17, 18, 19 respectively. At one end of the outer casing 1, there is an inlet 25 having a throttle valve 32.

The outer periphery of the other end of said casing 1 is eccentrically enlarged so as to form a whirl-shaped chamber 27 the cross sectional area of which is in a plane intersecting the centerline of the rotary shaft and forming a whirling path that gradually enlarges up to the outlet in the direction of the rotation of said shaft as indicated by an arrow in FIG. 1.

As the shaft 4 rotates, the impeller 7 and rotors 16, 17, 18 and 19 are rotated with high speed whereby there is produced a high-speed airstream around the inner wall of the cylindrical casing 1 whirling in a direction of the rotation of the rotary shaft 4. The speed of the airstream is somewhat reduced in the whirl-shaped chamber 27 so that suction is produced to introduce air from the outside of the pulverizer into the casing through the inlet 25 and thus the material with air is continuously discharged to the collecting device (not shown). In the inside of a number of chambers around the rotor 6 partitioned by adjacent blades 12 and discs 5 and 20, there is produced a turbulent air whirling with high-frequency pressure vibrations. Likewise in the inside of chambers around the rotors 17, 18 and 19, each partitioned by blades 13 and discs 20, 21; by blade 14 and discs 21, 22; and by blade 15 and discs 22, 23; respectively, there is produced turbulence with high-frequency pressure vibrations.

The material that is continuously fed from the inlet 25 is distributed by impeller 7 to the chambers around the rotor 16 and blown into said turbulent air whirl where it is subjected to pulverized action. Then with the airstream from the rotor 16 the material is carried to the outer face of the rotor 17 and pulverized as above and further likewise in the chambers of rotors 18 and 19, respectively. The material comes out the rotor 19 with air to the whirl chamber 27 and reaches the outlet 26.

The material is further carried through a piping connected with said outlet to the collecting device and from the bottom of a cyclone separator most of the material is discharged. A small volume of those extremely fine particles entrained in air is discharged from the top of said cyclone separator and supplied to the bag filter whereby it is separated from air and collected.

The volume of air passing through the inside of casing 1 may be controlled by the throttle valve 32 provided at the inlet 25.

In FIG. 3, there is shown a known conventional pulverizer of this kind in which a discharging impeller 30 with a number of radial blades 29 is provided at the end of a rotary shaft. Usually there is provided a conical or annular shape entrance mouth 31 for introducing air to the center of impeller 30.

FIG. 4 shows a relation between airstream and pressure rise in the apparatus with curves *a* and *b* representing respectively the embodiment of the present invention of FIG. 1 and the conventional one in FIG. 3. With reference of FIG. 1, the preferred dimensions are the inner diameter of the cylindrical casing 1 is 400 mm., the outer diameter of rotors 16–19 is 390 mm., the length in axial direction of blades 12–15 is 100 mm. and the length in radial direction is 55 mm., each rotor 16–19 has 14 blades, the outer diameter of the disc 5 is 360 mm. and the outer diameter of discs 20–23 is 375 mm. respectively. Revolution speed of the rotary shaft 4 is 5,000 r.p.m. Accordingly, the peripheral speed of rotors 16–19 is about 102 m./s. The impeller 30 in FIG. 3 is of outer diameter 390 mm., the diameter of the mouth is 270 mm., the width of blade 29 in axial direction is 32 mm. To control for testing purposes the volume of air in the device shown in FIG. 1, the throttle valve 32 at the inlet 25 is fully opened and a throttle is provided on the piping connected to the outlet 26.

When air supply is increased, it is possible to let is absorb heat produced by pulverization of material so as to lower the temperature of the pulverized material and discharged air. However, the time that material passes through the rotors 17,

18 and 19, that is, pulverizing time, is shortened so that the pulverized material becomes rough. Therefore with those of the above-mentioned size, it is not practically suitable for more volume of air then 15 m. ^{3}/min. The collecting device in the assembly of said cyclon and bag filter for separating the pulverized material from air discharged from the outlet **26** can well function with a pressure loss of less than 100–150 mm. of water column. Therefore, despite the fact that the present invention does not provide impeller **30**, it can secure sufficient air volume and discharge pressure as shown obviously by curve *a* and yet as compared with curve *b* of the conventional, it shows that with the air volume of more than 12 m. ^{3} /min., the discharge pressure is higher and the whirling velocity retained in air from the rotor **19** is still effectively utilized in the whirl chamber **27**. The curve *b* of the conventional apparatus shows that a loss is produced in the work to compress the whirling airstream to the mouth diameter of the impeller **30** against a centrifugal force applied thereto as much as about 5,600 times the gravitational acceleration whereupon while the peripheral speed of thus compressed whirling stream is increased to about 140 m./s. approximately in adversely proportion to the radius, the peripheral speed at the mouth to impeller **28** is about 70 m/s. in proportion to the radius so that therein a friction loss is produced, which loss is increased proportionately to the flowing volume of air (weight per unit time) whereby the pressure is greatly lowered than the discharge pressure at impeller **30** at the time when it is otherwise assumed that no such loss is present and as the volume of air increases, it is more lowered than curve *a*. When the pulverized material is entrained in the airstream, said loss is further increased. Following is a list showing a comparison of the pulverization of about 4 m./m. diameter pellet of a low-pressure polyethelane ("Hyzex M 15") using the conventional apparatus with that using the present invention.

	(1) The conventional	(2) The present invention	(3) The present invention (3)
Air Volume m.^{3}/min.	15	9	15
Pulverized Amount kg./h.	30	30	47
Consumed Power kw	20	25	20
Pulverized Granularity (Weight %)			
Over 20 mesh	0.5	0	0
20-35	4.0	0.5	1.0
35-65	49.0	9.0	32.0
65-100	40.0	46.0	57.0
Less 100 mesh	6.5	44.5	10.0
Total	100.0	100.0	100.0
Temperature of pulverized material	66	70	65

In this list, with the results from the conventional apparatus shown in column (1), the collected output of the pulverized powder in mesh smaller than 65 is 46.5 percent while that of the present invention is column (2) is 90.5 percent whereby it can be seen that the later is more suitable for the production of the pulverized powder of less than 65 mesh for use in fluidized bed coating and electrostatic spray painting.

Upon inspection of the pulverized material with the microscope, it was found that in the conventional pulverizer there were many rough granules mixed in which comprised several particles bound together or those shaped as a film piece. The material pulverized using the present invention resulted in nothing unsuitable for fluidized bed coating or like process. In this type of pulverizer, the temperature rise is relatively low compared with other impact and cutting-type pulverizer. However, the temperature rise at stage of rotors is unavoidable.

In this conventional pulverizer, the impeller **30** was provided in the discharge side to which air already hot after having passed successive rotors incurred an additional temperature rise of about 10° C. Due to this, when the volume of air is less than 15 m.^{3} /min. as referred to in column (1), the pulverized granules of material are subjected to high temperature thereby the granule particles tended to stick to one another to form a block so that said volume or less was not suitable. While in the apparatus of the present invention, as such impeller **30** is not provided, even when air is reduced to 9 m.^{3} /min. as shown in column (2) by the adjustment of the throttle valve **32**, continuous operation can be carried out and as a result, in the rotors **16**–**19**, the time of pulverizing action may be extended as a result of which very fine particles can be obtained.

In the conventional apparatus, the particles from the rotor **19** were impactly rubbed on the hot inner wall at the mouth **31** and reached the impeller **30** where they further impacted the blade **29** having an even higher temperature. This tended to produce rough particles in which several pieces came to stick to one another or form a film shape with particles flattened, whilst in the apparatus of the present invention, such disadvantages can be eliminated. As a guidance for column (3) of the list there is shown a case where the pulverized powder smaller than 35 mesh is produced in a greater quantity in contrast with the conventional process of the same row. In this instance, it is shown that the pulverizing amount is increased more than 50 percent per unit of time (30 kg./h. in the conventional apparatus, while 47 kg./h. in the present invention) and this is due to the absence of impeller **30** and mouth **31** which raises temperature and consumes some kws of power. In this instance too, any rough granules of several particles stuck to one another or film shaped granules were not present.

According to the present invention, it is possible to produce fine powder of synthetic resin sensitive to heat. in the production of granules having like size as is produced in the conventional apparatus, the production output per unit time can be greatly increased and rough granules of several particles stuck together or film shaped can be avoided.

In the conventional apparatus, when the granule of material turbulently rubbed the wall of the conical mount **31** or annular mouth to the impeller, a part of the surface of material melted and deposited on this surface thus requiring cleaning, while in the present invention, such can be avoided. It may be possible to make the impeller a large size and instead of said type of mouth, the diameter of a mouth is made same to the inner diameter of the cylindrical casing so that the defects in this area may be eliminated. However if such large size discharge impeller is employed, the peripheral speed of the impeller will become higher then the peripheral speed 102 m./s. of rotors whereby air volume will be excessively larger. To compensate, operation should be made by throttling the throttle valve. As a result, this large-size impeller will be operated with low efficiency and power loss and temperature rise will be greatly increased whereby the material will be impacted by hot blade **29** so as to produce a binding of particles of pulverized material. According to the present invention, such a defect is not necessary.

Further according to the present invention, as the impeller **30** and mouth **31** are dispensed with the manufacturing cost of the pulverizer is greatly reduced. When a different sort or colored material is to be pulverized, the inside of the apparatus should be cleaned each time. However, because of the lack of impeller **30**, very troublesome cleaning in the back of the apparatus is saved due to the easy access to the whirl chamber **27** which enables the cleaning to be conveniently done.

Further, due to the absence of impeller **30**, the weight of it is saved and hence the space between the journal boxes **2** and **3** of the rotary shaft is narrowed, the undesirable rocking vibration is lessened and therefore revolution speed may be enhanced if necessary.

THe present invention can apply not only for the pulverization of synthetic resin but also to the pulverization of other materials in which instance too, the power consumed per unit weight of material can be reduced. If the material pulverized is hard like oxidized steel, when pulverized with the conventional apparatus the impeller **30** was greatly worn. Such a defect can be eliminated with the pulverizer of the present invention due to the absence of such impeller **30**.

According to experiments, with said size of the apparatus according to the present invention, the peripheral speed of the rotors **16 –19** may not be limited to said 102 m./s. and even with that of said 50 m./s., in the certain air volume, the pressure rise is greater than that of the conventional, thus even with low speed, it can achieve pulverization very efficiently.

In the practice of the present invention, if instead from the inlet **25**, material is supplied from the side of outer casing **1** to the rotor **16** with provision of a screw feeder, the impeller **7** may be dispensed with. The ridges **24** on the inner wall of the outer casing may be dispensed with when damp, sticky material is to be pulverized. Rotors **16, 17, 18** and **19** may be more or less in number as necessitated.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows.

1. A pulverizer comprising: a cylindrical casing; and inlet for supplying air and material at one end of said casing; rotors having a plurality of radially extending blades and rotatable about a shaft in said casing; a disc-shaped impeller mounted on said shaft adjacent to said rotors at the upstream end thereof; and an annular chamber positioned adjacent said rotors and downstream from the same, said chamber having an entrance mouth diameter which is the same as that of the inner wall diameter of said casing.

2. The improved pulverizer as defined in claim **1**, wherein said chamber opens outwardly in a downstream direction from said entrance mouth to an exit at one point in said chamber, whereby pulverized material is carried into an outwardly whirling path as it leaves the vicinity of said rotors.

3. The improved pulverizer as defined in claim **1** wherein a throttle valve is provided in said inlet.

4. A pulverizer as described in claim **1** wherein the inner surface of said casing has a plurality of grooves thereon extending substantially parallel to said shaft, said extending blades on said rotor having a diameter slightly less than the inner diameter of said chamber so as to provide a slight clearance therebetween.

5. A pulverizer as described in claim **4** and further including a plurality of axially spaced flat discs between said rotors thereby forming a plurality of partitioned areas in said casing.

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