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Hosokawa et al.

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[54] **DEVICE FOR GRINDING SYNTHETIC RESIN OR LIKE HAVING LOW MELTING TEMPERATURE INTO POWDER**

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[52] **U.S. Cl.**..**241/88**

[51] **Int. Cl.**...**B02c 13/09**

[58] **Field of Search**.....241/17, 27, 65, DIG. 28, 299, 241/88

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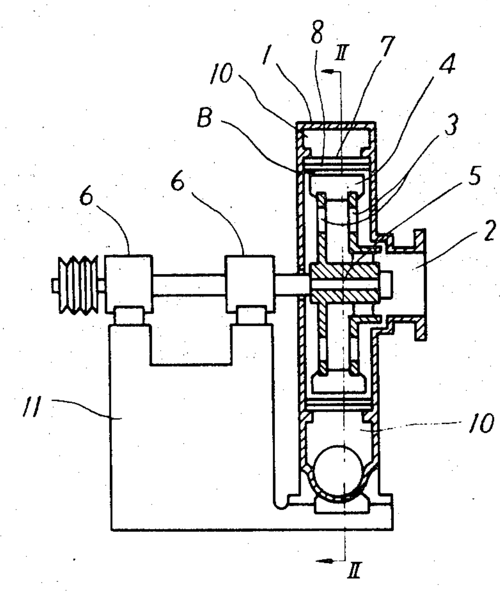
[57] **ABSTRACT**

Apparatus for pulverizing materials having low melting points wherein the temperature of the material is maintained just below the melting and softening temperatures by controlling the flow of material into the pulverizing rotor which is surrounded by a liner and coordinating the flow of material with the speed of the rotor and the temperature of the air carrying the material.

3 Claims, 6 Drawing Figures



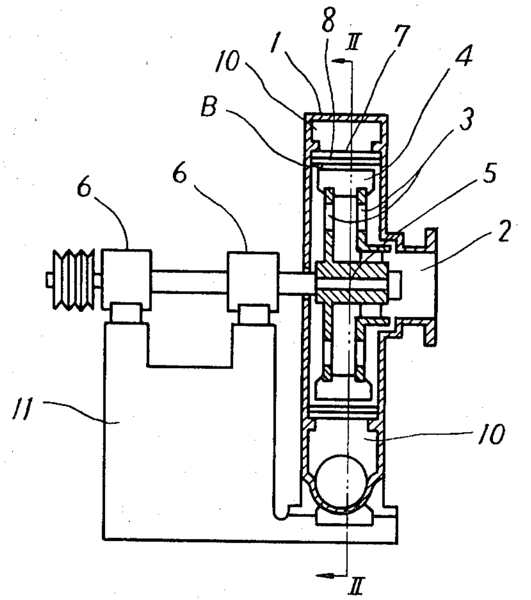


Fig. 1

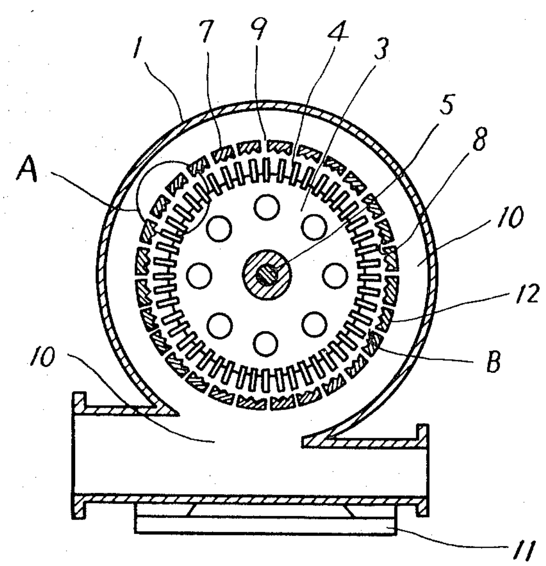


Fig. 2

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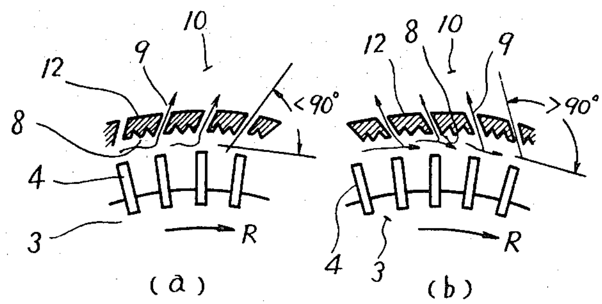

Fig. 3

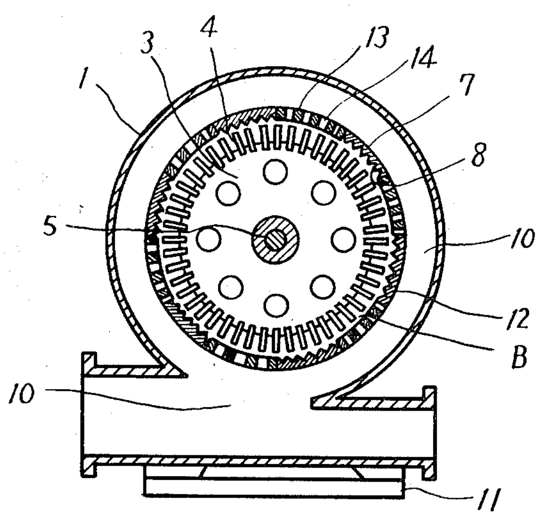

Fig. 4

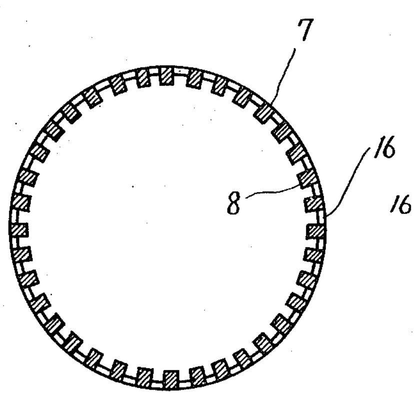

Fig. 5

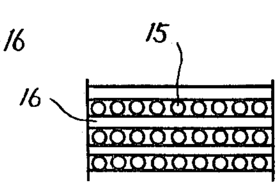

Fig. 6

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DEVICE FOR GRINDING SYNTHETIC RESIN OR LIKE HAVING LOW MELTING TEMPERATURE INTO POWDER

This invention relates to a novel and improved apparatus for pulverizing synthetic resins and similar materials having relatively low melting temperatures.

In the utilization of pulverizers for powdering materials having relatively low melting points, it has been the practice to utilize air at or below room temperature or coolants such as liquid nitrogen or dry ice which have been used to prevent calorification so that the particles will not fuse together. Such methods are uneconomical because of the relatively low efficiency and relatively expensive equipment required. Furthermore, the resultant produce has a nonuniform particle size and poor flowability and furthermore exhibits many other disadvantages in various applications.

One object of the invention resides in the provision of novel and improved apparatus for pulverizing materials having low melting points and without requiring the utilization of cooling apparatus.

According to the invention the material to be powdered by the pulverizer is maintained at a temperature in the vicinity but not exceeding its softening or melting point. It has been found that synthetic resins and similar materials having low melting points also have low breakdown stresses at temperatures in the vicinity of the softening or melting points, and accordingly, are more easily powdered at the higher temperatures than at the lower temperatures unless severe impact forces are utilized. When impact-type pulverizers are used, the material fed into the pulverizer rapidly collides with the rotating crushing vanes and the projections of the liner. This action causes a material increase in the internal temperature of the pulverizer. On the other hand, if the temperature is maintained just below the softening or melting temperature of the material, the breakdown stresses are minimized and the particles which are individually heated can be readily crushed.

In practicing the method in accordance with the invention, the temperature in the pulverizer is maintained substantially uniform and at a point just below but not exceeding the softening or melting temperature. This can be effectively attained by controlling the amount of material being fed into the apparatus, by controlling the flow rate, by controlling the temperature of the air, or by controlling the operation of the pulverizer itself. It is evident that any one or more of the foregoing can be utilized simultaneously. For example, in the event of overheating, the amount of material fed into the apparatus can be reduced, the rotation of the crushing rotor can be reduced, the circulation of air can be increased, and if desired, the air can be lowered in temperature. Should the temperature of the pulverizer be too low opposite procedures can be utilized to raise the temperature to the desired value.

The pulverizing apparatus in accordance with the invention includes a housing having an inlet port for introduction of the material and an outlet port for removal of the powdered material. A cylindrical liner is disposed within the housing and has a plurality of segments each including a number of projections arranged to form paths for guiding the material toward the outlet port and a crushing rotor having a plurality of vanes, the ends of which are spaced from the inner surface of the liner.

The above and other objects of the invention will become more apparent from the following description and accompanying drawings forming part of this application.

In the drawings:

FIG. 1 is a side elevational view in partial section of one embodiment of the invention;

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

FIGS. 3*a* and 3*b* are enlarged views in partial section of the area A of FIG. 2;

FIG. 4 is a cross-sectional view similar to FIG. 2 showing a modified embodiment of the invention;

FIG. 5 is a cross-sectional view of a liner for a pulverizer in accordance with the invention; and

FIG. 6 is a plan view of a fragmentary portion of the liner illustrated in FIG. 5.

Referring to the embodiment of the invention illustrated in FIGS. 1 to 3, the device is provided with a housing 1 having an inlet port 2 and a crushing rotor 3, the latter having a plurality of crushing vanes 4. The number of crushing vanes 4 is preferably made as large as possible in order to increase the area for applying impact to the material being crushed. The crushing rotor 3 includes an annular passage for introduction of the material to be crushed and air from the inlet port 2 to the rotor 3. The outlet port of the rotor consists of the radially disposed openings or gaps between the crushing vanes 4. An annular liner 7 is disposed about the crushing rotor 3 and includes a plurality of segments 12 each having a number of inwardly extending projections 8 which are arranged in an annular configuration at appropriate intervals to form radial passage ways 9. The passage ways 9 may be at right angles to the direction of rotation of the crushing rotor 3 or may be inclined relative thereto as illustrated in FIGS. 3*a* and 3*b*. The direction, angle of inclination, and aperture of the passage ways can be selected in accordance with the properties of the material to be crushed and the temperature to be maintained within the pulverizer. The passage ways 9 communicate with the product exhaust or outlet 10 between the housing 1 and the liner 7. The rotor 3 has a shaft 5 supported by bearings 6, the latter being carried by a base 11. The rotor may be driven by any suitable motor not shown.

The magnitude of the gap B between the crushing vanes 4 and the liner 7 is preferably about twice the size of the particles to be pulverized. The impact crushing force is maximum when the gap is slightly greater than the particle size. Narrower gaps result in larger shearing forces which require increased torque and results in decreased efficiency. On the other hand, wider gaps result in the accumulation of increased material which causes an increase in friction of the particles of material one with the others and with the inner face of the liner 7. This results in a reduction of the impact or crushing forces and produces substantial overheating.

In the operation of the device as described above, the material to be pulverized is fed through the inlet port 2 and into the passage way in the rotor 3. The centrifugal force applied to the material causes it to move outwardly through the gaps between the crushing vanes 4 and collide with the projections 8 of the liner 7. This produces a substantial impact force and heat is produced by reason of such impact. When the temperature is increased to a point just below but not exceeding the softening or melting temperature of the material, the material will be easily crushed by reason of the impact. Even if the material is accidentally overheated or locally heated, the heat is released through the passage ways **9** formed by the spaced liner segments **12**, and this action prevents fusion of the crushed particles. The crushing temperature can be maintained at a desired value by controlling the amount of material fed into the rotor, the size of the passage ways **9**, the flow rate and the temperature of the air fed to the inlet port **2**.

Referring to FIG. **4**, which illustrates a modification of the invention, perforated plates **13** are disposed between the liner segments **12**. Each perforated plate **13** has a plurality of small holes **14** which serve as passage ways for the finely divided particles and air and aids in pulverizing the material to obtain the desired particle size. More specifically the small holes **14** function as a sieve as well as functioning in the same manner as the passage ways **9** of the pulverized shown in FIG. **1**.

FIGS. **5** and **6** illustrate a further modification of the liner **7** as shown in FIG. **1**. The liner **7** of FIG. **5** and **6** consists of an alternate arrangement of projections **8** and depressions **16**. Each depression **16** has a plurality of holes **15** extending therethrough as illustrated in FIG. **6**. With this arrangement the material is crushed by the projections **8** and at the same time releases its heat upon passing through the holes **15**. This results in the effective dissipation of heat and prevents overheating of the material and greatly facilitates mass production of the powdered material.

With the invention as described above, it is possible to pulverize synthetic resins and other similar materials having low melting points which in the past have been extremely difficult if not impossible to powder. The following table illustrates an example of the operation of one embodiment of the invention:

Material:	Low density polyethylene (Melting Point 115°C)
Power of pulverizer:	30 h.p.
Flow rate of air:	30 cu. meters/minute
Air temperature at inlet:	15°C
Air temperature at outlet:	68°C
Crushing temperature (estimated):	110°C
Capacity:	96.0 kilograms/hour
Average particle size of product:	600 microns
Particle shape:	good

As shown in the foregoing table, the pulverizer in accordance with the invention has a very high pulverizing efficiency of the order of 3.0 to 3.5 kilograms per horse power hour. The highest efficiency obtainable with prior known pulverizers has been 1.0 to 1.2 kilograms per horse power hour. Furthermore, the particles of powdered material produced in accordance with the invention do not have so-called "whiskers" or fiber-like projections which are characteristic of products formed by prior known pulverizers for low temperature materials.

While only certain embodiments of the invention have been illustrated and described, it is apparent that alterations, modifications and changes may be made without departing from the true scope and spirit thereof as defined by the appended claims.

What is claimed is:

1. A device for pulverizing synthetic resins and other materials having relatively low melting points comprising a housing having an inlet port, an annular liner within and spaced from the wall of said housing, a crushing rotor within said annular liner and rotatable in one direction, said annular liner being formed of a plurality of segments, spaced one from the other to form gaps therebetween, said gaps being inclined in a direction opposite to said rotation, each of said segments having a plurality of inwardly extending projections, (a) said crushing rotor having a plurality of vanes arranged concentrically within said liner and having their outer edges spaced from said projections, and means for exhausting the powdered material emerging from said liner.

2. The device according to claim **1** wherein a perforated element is disposed within each of said spaces between the adjoining segments of the liner.

3. The device according to claim **1** wherein said distance between said vanes and said projections is generally of the order of twice the size of the particles to be pulverized.

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