March 29, 1927. 1,622,849

L. RUPRECHT ET AL

METHOD OF AND MACHINE FOR GRINDING

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Fig. 2.

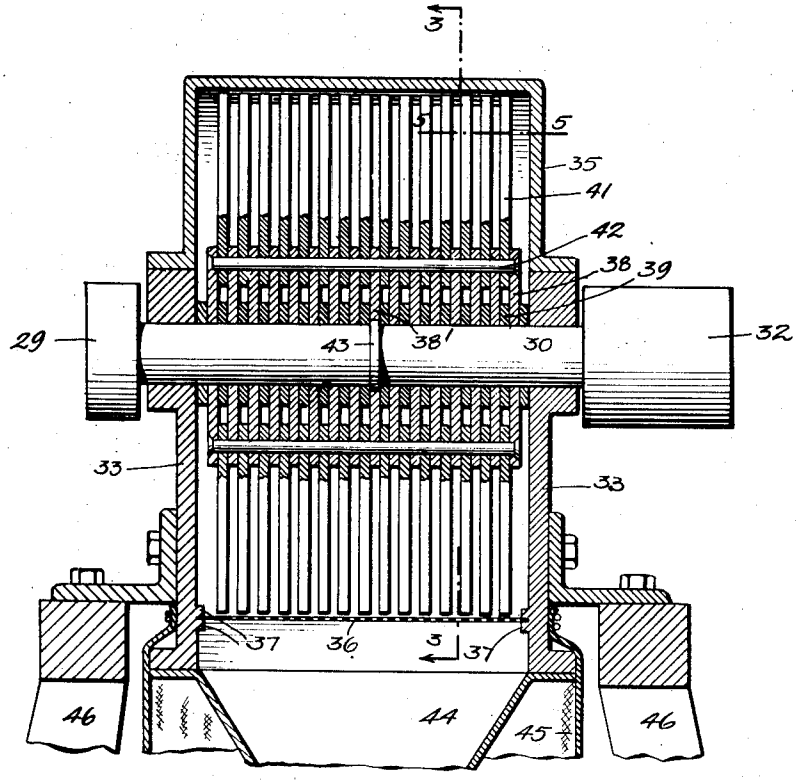



Fig. 1.

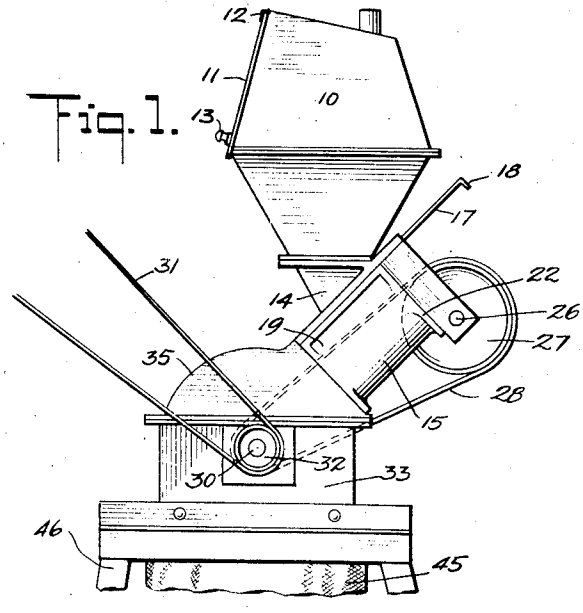
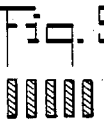



Fig. 5.



INVENTOR
Louis Ruprecht
Alfred G. Kolleleide
BY
Northcutt Ker
His ATTORNEY

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Fig. 3.

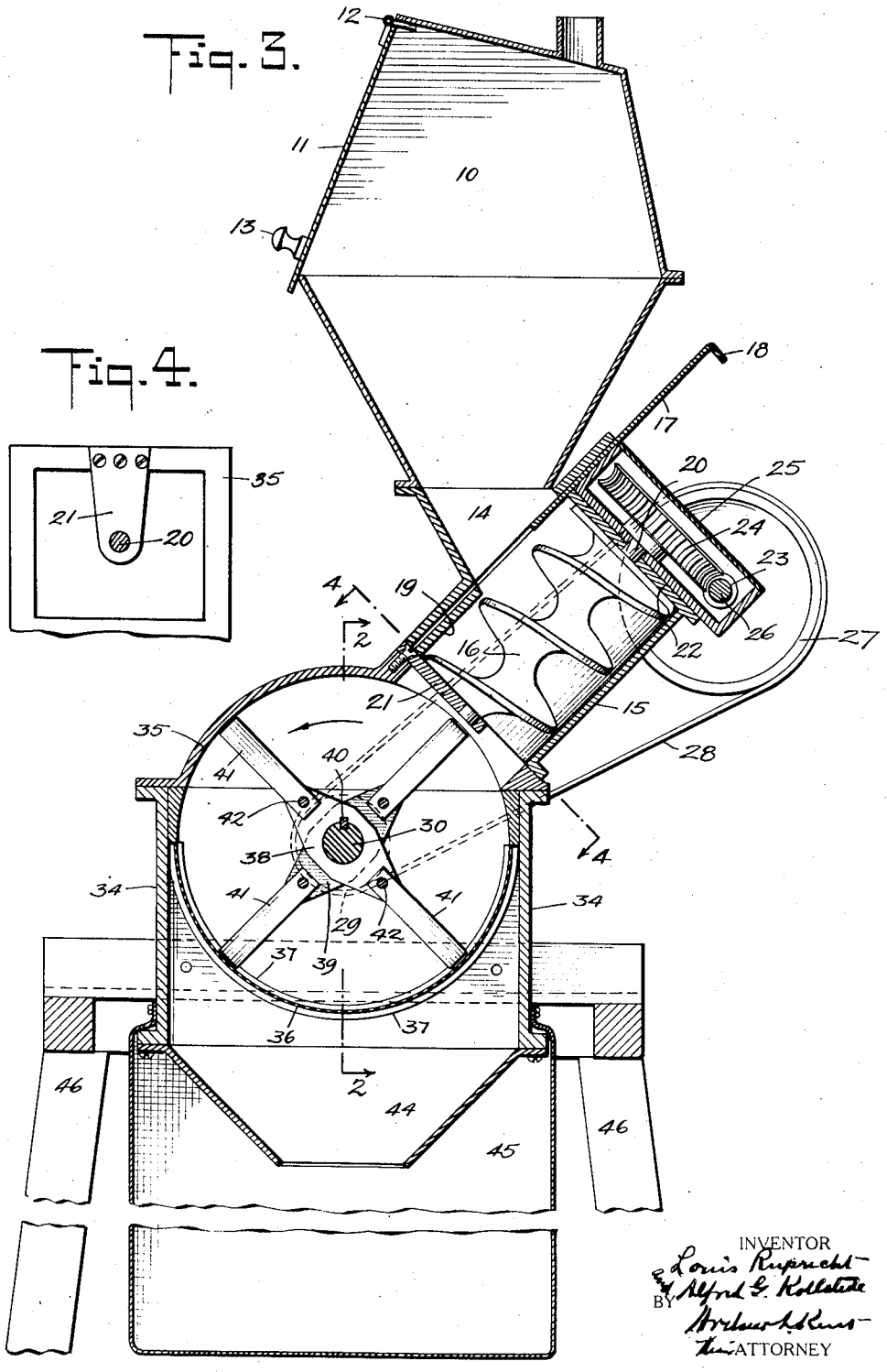



Fig. 4.




INVENTOR
Louis Ruprecht
& Alfred E. Kollstede
BY Arthur A. Kemp
ATTORNEY

Patented Mar. 29, 1927. 1,622,849

# UNITED STATES PATENT OFFICE.

LOUIS RUPRECHT, OF MONTCLAIR, NEW JERSEY, AND ALFRED G. KOLLSTEDE, OF NEW YORK, N. Y.

## METHOD OF AND MACHINE FOR GRINDING.

Application filed July 16, 1924. Serial No. 726,254.

This invention relates to a method of and a machine for performing grinding or like comminuting operations, and adapted to the requirements of various industries, such as color grinding and numerous other purposes, some examples of which will be enumerated hereinafter.

The object of our invention is to provide a machine of the character referred to, which will exhibit the qualities of great ruggedness and durability with compactness and simplicity, so far as construction is concerned. As to operation, the new machine is remarkable for the fineness to which various materials may be reduced, for its large output of uniform product, its lower power requirements, the absence of any perceptible or detrimental heating of the material even during very fine grinding, the avoidance of dust, and the readiness with which adjustments may be made to vary the fineness of the grinding. Other features of the invention will be brought out in the course of the description following below.

Without desiring to restrict ourselves to the particular features illustrated, we will now describe, as an example, a satisfactory and typical embodiment of the apparatus features of our invention, as shown in the accompanying drawings, and the operation thereof. In said drawings:—

Fig. 1 is an elevation of such machine, with parts broken away;

Fig. 2 is a vertical section substantially on line 2—2 of Fig. 3, but assuming two of the sets of beaters in a vertical position;

Fig. 3 is a vertical section on the line 3—3 of Fig. 2;

Fig. 4 is a detail view, substantially on the plane indicated by the line 4—4 of Fig. 3; and

Fig. 5 is a detail view on the line 5—5 of Fig. 2.

At 10 we have shown a hopper or bin forming a container for the material to be treated. This container may have a hood or cover 11, hinged at 12 and provided with a knob 13 or other means for its ready manipulation. The container 10 is shown as contracted downwardly, and its outlet portion 14 opens into a feedway, or conduit, provided by a casing 15, which leads to the rotor chamber and in which is located a rotary feed screw 16. The connection of the container 10 with the interior of the casing 15 is controlled by a gate valve or slide 17, projecting to the outside and provided with a handle 18. In order to obtain the best results, it is desirable to extend the casing 15 inwardly a sufficient distance beyond the opening to the container 10 to provide a closed conduit through which the material will be fed to the rotor in a suitably compacted mass and to insure an efficient sealing of such extension 19 of the casing by the material therein. We have found it desirable to extend the feed screw into the closed conduit or extension 19 to a point close to the rotor, and when the feed screw is so extended the extension is most desirably at least as long as the distance between two successive threads of the screw 16, or, in other words, the length of such extension is at least equal to the pitch of the feed screw 16 if the latter is of the single thread type.

The inner end of the screw shaft 20 may be journaled in a bearing plate 21, and its outer end in the end wall 22 of the casing 15. This outer end is driven in any suitable manner, for instance, by means of a worm 23 meshing with a worm wheel 24 on said shaft 20. This drive may be enclosed in a separate casing 25. On the shaft 26 of the worm 23 is secured rigidly a pulley 27 driven, as by a belt 28, from a pulley 29 on the main shaft 30 of the machine. Fig. 1 indicates a belt 31 for actuating the main shaft 30 from a suitable shaft (not shown) through the medium of a second pulley 32 on the shaft 30. The latter is journaled in the end walls 33 of a suitable casing which also comprises side walls 34 and a top wall 35 of circular curvature in cross-section (Fig. 3), said wall being preferably curved cylindrically, as shown. The inner surface of this casing wall 35 is preferably somewhat rough. The roughness resulting from the casting of this wall will provide a surface of proper character for the purpose of this invention. The cylindrical surface of which said wall 35 forms part is completed by a screen 36 of like curvature, which screen is illustrated as having its semicircular edges set in two grooves formed by arcuate ribs 37 on the end walls 33. This screen may be a perforated plate of metal either punched or milled, or a woven wire screen may be employed. While such screen is desirable, especially where fine pulverizing is

intended, and to insure a more uniform product, satisfactory results may be in some cases obtained without such screen.

On the shaft 30 within the main chamber provided by the casing above described is mounted the rotor of the grinding machine or mill. In the specific embodiment shown, the rotor comprises two sets of carriers or hubs 38, 39 arranged alternately in contact with each other, and held to rotate with the shaft, as by means of a key 40. The hubs 38, 39 are elongated, those of the set 38 extending at right angles to those of the other set 39, see Fig. 3. Owing to the alternate arrangement of these hubs, successive hubs of the same set are spaced from each other, and in the spaces between the outer portions of such hubs we arrange the impact members or hammers 41, mounted on rods 42 which extend parallel to the shaft 30, through the inner end portions of such hammers and through the outer end portions of the respective hubs 38 or 39. These hammers may be fitted between the hubs either tightly, so as to form a rigid rotor unit therewith, or loosely, so as to be able to swing on the rods 24. Longitudinal movement of the rotor may be prevented or limited by the engagement of the first and the last hubs with the end walls 33 of the casing. Furthermore, the central hub (38′) may have a central opening large enough to clear the key 40 and to receive a collar 43 rigid on the shaft 30 and projecting between the two neighboring hubs 39, thus preventing relative longitudinal movement between the rotor and its shaft. While this particular hub 38′ does not engage the key 40, it is tied to the other hubs 38 of the same set, by the rods 42, and will thus be compelled to rotate in unison with the shaft 30.

We prefer to make the hammers 40 of rectangular section (Fig. 5), with the shorter edges of the rectangles forming the active or forward surfaces, transverse to a plane of rotation, and these edges probably work more efficiently when they are made sharp.

The lower side of the main chamber in which the rotor operates may be provided with a funnel-shaped outlet 44 over which may be slipped the upper end of a bag 45 or other container to receive the ground product. The machine is supported on any suitable standards or frame, parts of which are indicated at 46.

While it will be evident that the machine may be constructed in different sizes and with different proportions of its elements, we believe it desirable to disclose the specific dimensions of an example as actually constructed for pulverizing lake colors. The hammers 41 were made of ¼″ by ¾″ heat treated high grade steel bars cut to lengths of 4⅜″, their ends being cut off square, that is to say, tangential to the circular path of rotation. The rotor (hubs 38, 39, rods 42, and hammers 41, the latter in the extended or radial position shown in Fig. 3) was of a diameter (at the free hammer ends) of 12 inches, while the axial length of the rotor was about 8 inches. The clearance between the free ends of the hammers and the cylindrical surface formed by the top wall 35 and screen 36 was a little less than one-eighth of an inch. The screen 36 had $\frac{1}{32}$″ openings spaced about $\frac{1}{16}$″ between centers. We found that with the rotor running at about 2500 revolutions per minute, this particular mill will grind approximately 1000 lbs. per hour to a fineness of about 100 mesh. The same machine, with the rotor speed increased to about 5000 revolutions per minute, will grind Prussian blue (a harder material) to a fineness of over 95% through a 275 mesh screen, at the rate of about 500 lbs. per hour.

The manner of operating our improved mill, and its advantages, are as follows:—

The material to be comminuted or ground, or otherwise treated, is charged into the hopper 10, after opening the hood 11, and preferably while the slide 17 is in its inner or closed position. Then the hood 11 may be closed and the slide 17 is opened. The material will then pass by gravity through the outlet portion 14 of the hopper to the interior of the casing 15 and into contact with the feed screw 16, the latter being rotated in the proper direction to force the material inwardly through the extension 19 toward the main chamber in which the rotor revolves. In special cases, where gravity will not suffice to cause the material to flow properly from the hopper to the feed screw, we may find it desirable to provide a spring-pressed follower or other device to supplement the action of gravity. Most materials, however, will flow readily under the sole influence of gravity.

The feed screw or worm 16 forces the material into the path of the rapidly rotating hammers and keeps up a continuous uniform supply of such material as long as the charge contained in the hopper lasts. The outer edge or periphery of said feed screw is quite close to the inner surface of the casing 15, and a practically solid or compact body of material surrounds that portion of the feed screw which lies between the outlet of the hopper and the lower end of the extension 19. This forms an effective safeguard against the throwing or blowing of any dust or powder from the main or rotor chamber of the mill back through the extension 19 and hopper 10. It is desirable that the axis of the feed screw 16 and its casing 15, 19 extend radially of the axis of the rotor, and it is of advantage also, especially for grinding some materials, to have the feed screw and its casing inclined downwardly in the direction of feed in order that

the feed action of the screw shall be assisted by the force of gravity, and to obtain a more effective gravity feed of the material from the hopper to the feed screw. The plate 21 reduces but slightly the area of the passage through which the feed screw delivers the material to the main chamber; this plate might be omitted. While we have shown the feed screw in connection with a device for operating it by mechanical power, we do not wish to restrict ourselves to this, and in some cases the shaft 20 might be actuated manually, in any well-known or approved manner, for instance by projecting the upper end of said shaft beyond the casing and mounting a crank handle on such end of the shaft.

The hammers, and particularly their outer ends, strike a large number of strong quick blows upon the particles forced into their path in a direction which is substantially radial relatively to the rotor, and by this impact action of the hammers on the material in suspension the material is ground or comminuted very efficiently. The grinding action is assisted by the squeezing or crushing of the material between the outer ends of the hammers and the rough inner surface of the top wall 35. The material thus treated is not whirled around indefinitely in the main chamber of the mill, but is thrown down into the funnel-shaped outlet 44, both by gravity and by centrifugal force, passing through the screen 36 if the mill is provided with such a screen, the latter helping to complete the grinding, especially securing a higher degree of uniformity, as the hammer ends force the material against and over the screen and through the meshes thereof. With many materials there is apparently no perceptible heating of the material in the grinding chamber, and with all materials there is much less heating than in other similar machines not provided with special cooling means. The clearance between the outer ends of the hammers and the adjacent cylindrical surfaces is relatively small and, so far as we know, much closer than has ever been used before in rotary grinders or pulverizers. The smaller the clearance and the finer the screen, the finer and more uniform will be the grinding. The clearance would be chosen greater when coarser grinding is desired, and smaller for finer grinding, the length of the hammers being selected according to the specific purpose in each individual case. When a screen is used, its area and fineness would also depend on the desired fineness of grinding. The pressure exerted by the feed screw 16, or in other words, the rate at which it forces the material into the treatment chamber, may also be increased or decreased (as by changing the rate at which the shaft 20 is rotated relatively to the rate at which the shaft 30 revolves) to vary correspondingly the fineness of the grinding and the output of the machine. Increasing the speed of the rotor has also been found to increase the fineness of grinding and the output per unit of time. In case the screw 16 should feed too much material, so as to cause the rotor to become overloaded, this condition, when a belt drive is employed, will reveal itself to the attendant by the slippage it will cause on the belt drive 28 of the feed screw, and thus there is a specific advantage in employing for the feed screw a drive that will allow slippage in the event of overloading. Any well-known or approved device (stepped pulleys, etc.) may be used in conjunction with the drive of our improved mill to enable the speed of the parts to be adjusted as desired. The close spacing of the hammers in the same row, and the staggering of the hammers in successive rows, results in a thorough comminution of the material since no particle thereof can escape the action of the practically continuous cutting edge of the rotor.

When all of the material has passed out of the hopper to the feed screw, said slide may be closed, so that no dust can be blown back from the main chamber to the hopper after the seal formed by the material around the feed screw has been broken by the passage of nearly all the material into the main or rotor chamber.

An important feature of the machine is that, after the container 45 is placed in position, the material being operated on is contained within a practically dust-tight enclosure, and thus the operation is dustless, that is, no dust, or substantially none, issues from the machine, thus avoiding one of the objectionable characteristics of mills used hitherto for similar purposes. There are no tailings, and therefore no need of accessory apparatus for returning tailings to the main chamber, and because of the uniformity of the product there is no need of providing devices for separating the fine from the coarse such as what are known as "air-separation" devices. An important advantage of not having to use such separating devices is the resulting reduction of the explosion and fire hazard. The rate of feed can also be adjusted to a limited extent by moving the side 17 to different positions, without making any other adjustment in the position of the parts, or in the speed at which they are moving. The material is fed into the path of the rotor in a practically continuous mass of compact nature, from which the hammers as it were shave off a thin layer continuously.

The machine is exceedingly compact, and requires but little floor space. As the rotor does not come in contact with the surfaces of the parts 35, 36 cooperating therewith,

there is, in the grinding of relatively non-abrasive materials such as colors, dyestuffs, etc., practically no wear of the hammers or of these parts, and no gradual change in the fineness of grinding such as would result from wear. The result of the operation will therefore remain uniform, without any adjustments to take up wear. The alternate or staggered arrangement of the hammers is of importance in allowing a very compact construction of the rotor as well as in providing a practically continuous active or cutting edge of the rotor as before stated, and the particular way of mounting the hammers with the aid of the hubs 38, 38', 39, rods 42, and central collar 43, enables us to dispense with lock nuts and collars at both ends of the rotor. Thus the entire space within the treatment chamber is utilized for work. Actual tests have shown that the machine has a remarkable capacity or output, with relatively low power requirements. The forced feed effected by the screw 16, and the staggered blows delivered by the sets of hammers 41 operating in different planes of rotation, are important factors in securing such increased capacity.

We have given as an example of the use of the machine, the grinding of colors such as lakes and Prussian blue. The mill is adapted for the fine grinding, comminuting or pulverizing of all kinds of materials that are susceptible of being so treated. Among other substances that have been ground successfully in our mill we may mention salts including table salt, sugar, various chemicals, bark, spices, coal, hay, flour, and grains, which we have reduced to fine and practically impalpable powder. Features of the invention may be found adaptable to machines for the relatively coarse grinding of various materials, as in cracking corn for chicken food, and in producing granulated charcoal.

While the machine has generally been employed for grinding dry materials, it has also been found suitable for grinding moist or pasty materials and materials which become gummy or melt at relatively low temperatures, such as chocolate. All the parts of the machine are readily accessible for cleaning. The hopper with the upper part of the main chamber casing may be lifted off after removing the bolts holding it down. The entire machine may be flushed with water to remove traces of material from a preceding operation, particularly when a different material is to be treated at the next operation.

Various modifications may be made without departing from the invention as set forth in the appended claims.

What we claim is:

1. A machine of the class described, comprising a main casing providing a cylindrical chamber, a high speed rotary grinder in said chamber, a feed conduit extending radially outward from said chamber at a substantial angle from the vertical and having a supply opening at a distance from the inner end thereof, and a feed screw mounted to turn in said conduit and extending into the conduit beyond the supply opening for a distance at least equal to the distance between two adjacent threads of the feed screw and the inner end of the feed screw being close to the periphery of the rotary grinder.

2. A machine of the class described, comprising a cylindrical casing, a high speed rotary grinder therein, a closed conduit extending outward from an opening in the peripheral wall of said casing and having a supply opening at a distance from the inner end thereof, and a feed screw mounted axially of said conduit and extending into the closed conduit beyond the supply opening for a distance at least equal to the distance between two adjacent threads of the feed screw, the conduit extending in a direction to feed the material in a direction toward the axis of the grinder at such an angle from a vertical downward direction that the tendency of the material to fall by gravity through the conduit is substantially reduced.

3. A machine of the class described, comprising a main casing, a high speed rotary grinder therein, a feed conduit extending radially outward from an opening in the periphery of the main casing at a substantial angle from the vertical, a feed screw mounted to turn in said conduit, the latter being provided with an admission opening in the side thereof at a substantial distance from the inner end thereof so that the material about the inner end portion of the screw will form a practically compact barrier to the blowing out of fine material in a direction opposite to the feed direction, and that the material will be fed in a compacted mass against the grinder.

4. In a machine of the class described, a casing, a shaft journaled therein, elongated carriers held to turn with said shaft and mounted thereon alternately in one position and in another position at right angles to the first, one of said carriers having a larger central opening than the others, a collar located on the shaft within such larger opening between two adjoining similarly-positioned carriers to prevent relative longitudinal motion of the shaft and carriers, and hammers mounted between similarly-positioned carriers.

In testimony whereof, we have hereunto set our hands.

LOUIS RUPRECHT.
ALFRED G. KOLLSTEDE.