Aug. 20, 1929. A. W. McALLISTER 1,725,155

GRINDING MACHINE

Filed May 21, 1927 3 Sheets-Sheet 1

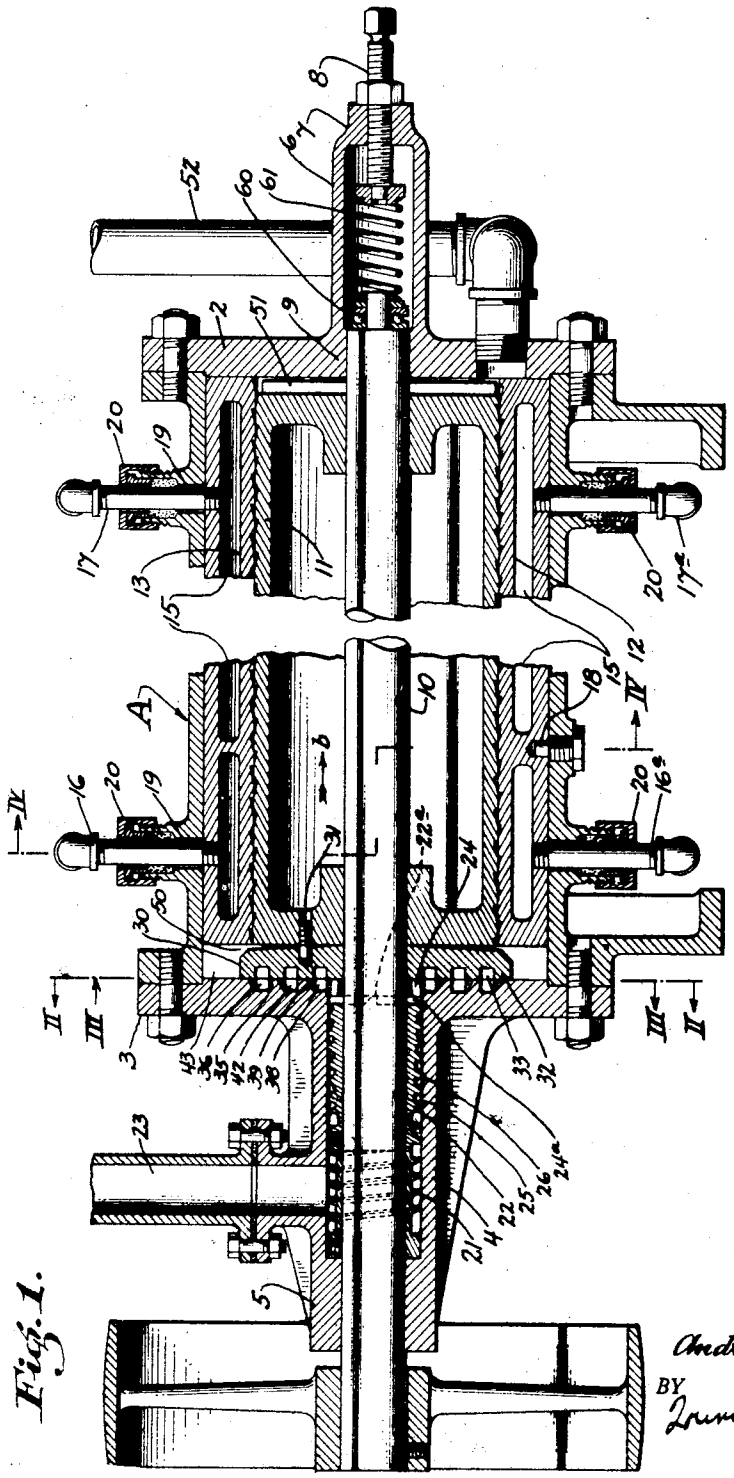


Fig. 1.

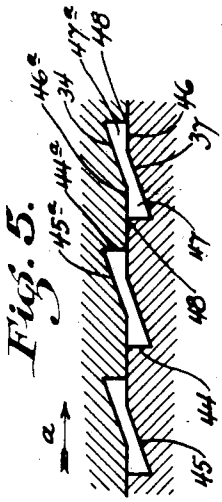


Fig. 5.

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Filed May 21, 1927 3 Sheets-Sheet 2

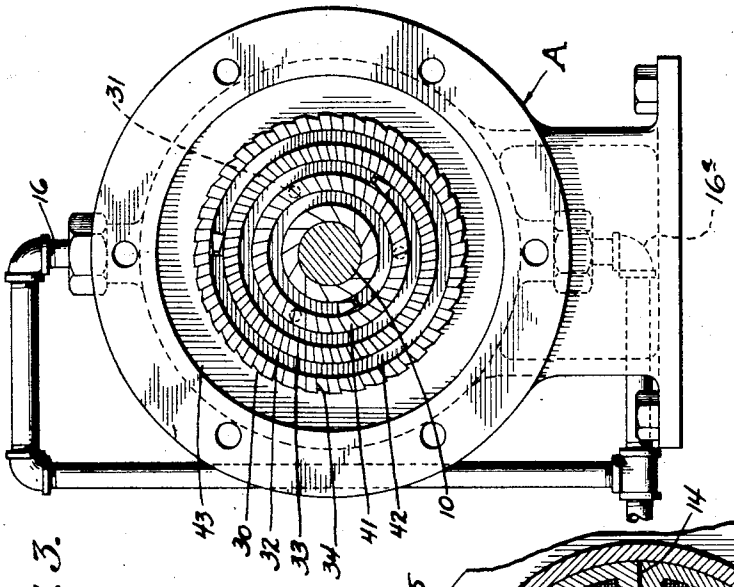


Fig. 3.

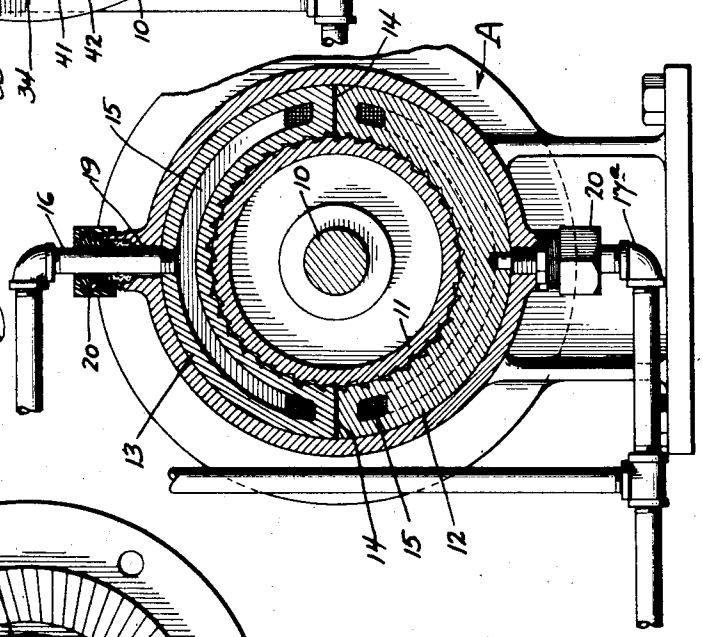


Fig. 4.

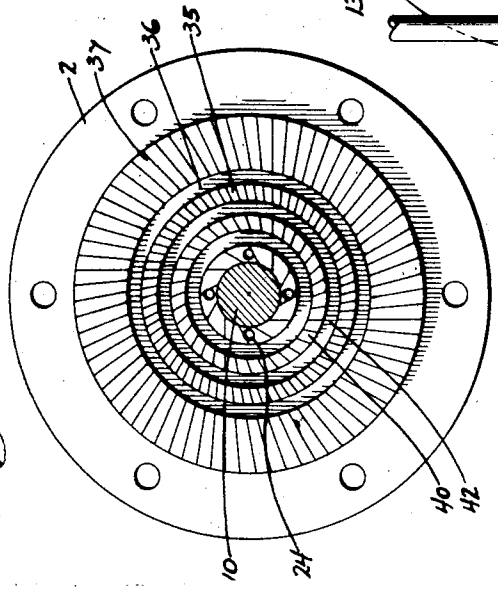


Fig. 2.

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Filed May 21, 1927 3 Sheets-Sheet 3

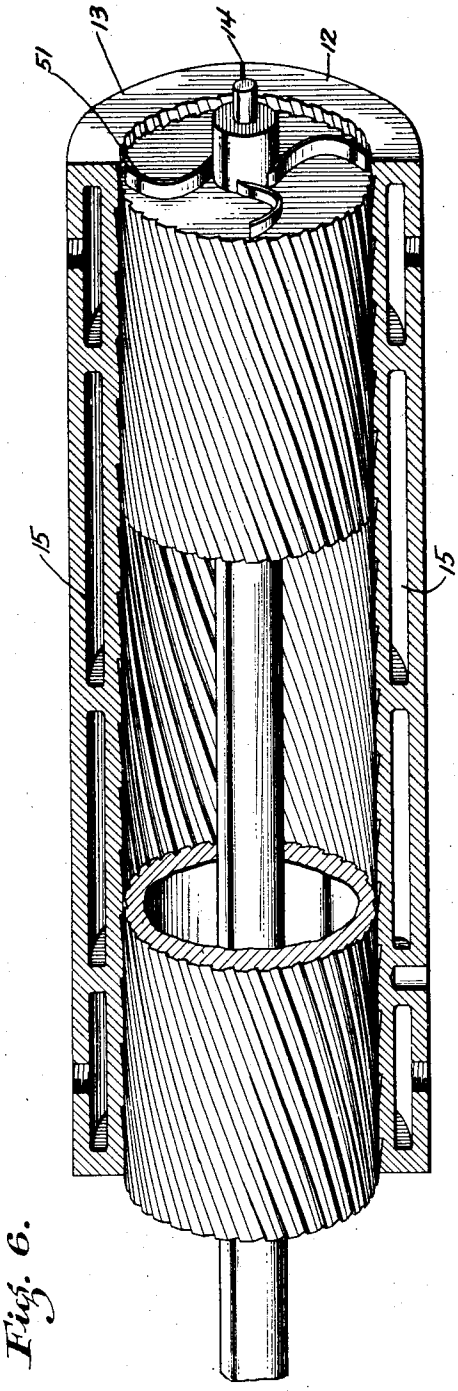


Fig. 6.

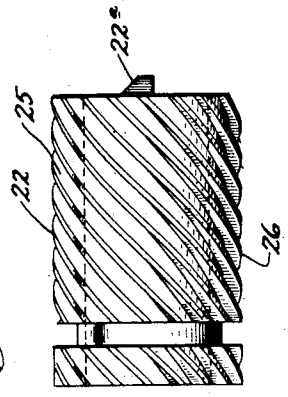


Fig. 8.

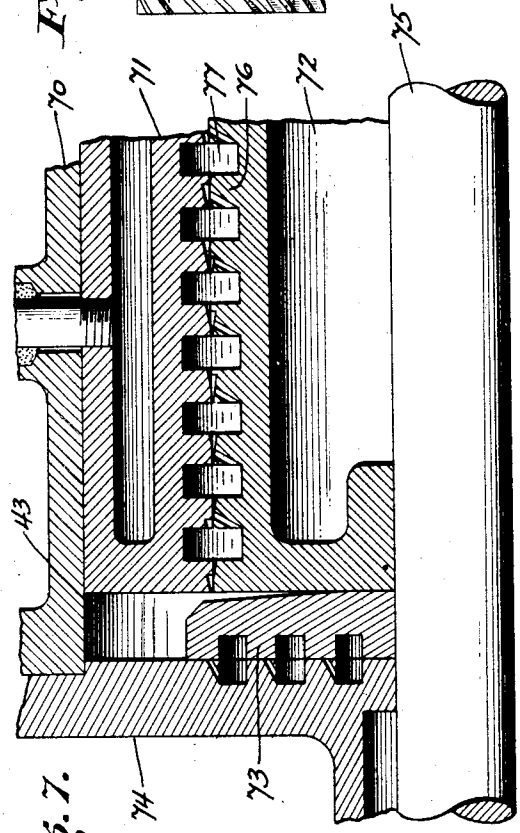


Fig. 7.

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UNITED STATES PATENT OFFICE.

ANDREW W. McALLISTER, OF SAN FRANCISCO, CALIFORNIA.

GRINDING MACHINE.

Application filed May 21, 1927. Serial No. 193,081.

This invention relates to a grinding machine and especially to a type of grinding or rubbing machine in which solids and semi-solid substances may be ground to fineness comparable or equal to particles reduced to a colloidal or molecular state.

In the manufacture of chocolate it is first necessary to roast the cocoa beans; second to crack and hull the beans; third to grind the roasted cracked beans; fourth to mix the ground cocoa beans with cocoa butter, sugar, milk, etc., fifth to pass the mixture through a finishing machine and sixth, to rub the mixture in a conging machine to obtain chocolate.

A number of machines are required for the several operations and as the quality and homogenity of the several ingredients employed is entirely dependent upon the fineness to which the chocolate and sugar are ground, considerable care and skill is required.

The object of the present invention is to generally improve and simplify the construction and operation of grinding machines of the character described; to provide a grinding machine which operates on a rotary principle and which is capable of grinding or reducing solids, semi-solids, etc., to fineness comparable or equal to particles reduced to a colloidal or molecular state; to provide a grinding machine in which the material to be ground is progressively reduced to the fineness required, and further to provide a grinding machine in which wedge-shaped step-like grinding and rubbing surfaces are employed between which the material to be ground is pulled out to a thin film, and while in the film condition, subject to a comparatively heavy pressure and rubbing action.

The invention is shown by way of illustration in the accompanying drawing in which:

Fig. 1 is a central vertical longitudinal section, through the grinding machine.

Fig. 2 is a cross-section taken on line II—II, Fig. 1, said view showing the grinding teeth or surfaces formed on one of the cylinder heads.

Fig. 3 is a cross-section taken on line III—III, Fig. 1, said view showing the grinding teeth or surfaces formed on the floating grinding disc.

Fig. 4 is a cross-section taken on line IV—IV, Fig. 1.

Fig. 5 is a diagrammatic view, showing the shape of the grinding teeth employed, both on the stationary and on the movable parts.

Fig. 6 is a perspective view of the grinding rotor, said view being partially broken away to disclose the interior surface of one of grinding shoes.

Fig. 7 is an enlarged detail section, showing a modified form of grinding rotor.

Fig. 8 is an enlarged side elevation of the breaking rotor.

Referring to the drawings in detail and particularly Fig. 1, A indicates an elongated cylinder, the opposite ends of which are closed by means of head members, such as indicated at 2 and 3.

The head member 3 is provided with a tubular or cylindrical shaped extension 4 the outer end of which terminates in a bearing member 5.

The head member 2 similarly has a cylindrical extension or housing 6, which is closed at the outer end, as at 7, to receive and support an adjusting screw 8. The inner end of the extension 6 is provided with a bearing 9. The bearings 5 and 9 align and they support a main drive shaft, generally indicated at 10.

Keyed, or otherwise secured on the shaft 10, within the cylinder, is a grinding rotor 11 and interposed between the grinding rotor and the cylinder A, are a pair of sleeves or grinding shoes, 12 and 13. These shoes are best illustrated in Figs. 1 and 4.

By referring to Fig. 4 it will be noted that the shoes are made in two half sections, the division line between the two half sections being indicated by 14. It will also be noted that each shoe is water-jacketed, as indicated at 15, and that circulating water is delivered through pipes, 16 and 17, the pipe 16 forming the inlet pipe for the circulating water and the pipe 17 the discharge pipe.

The lower shoe is similarly provided with water inlet and outlet pipes, as indicated at 16^a and 17^a, and continual circulation of water is maintained when the machine is in operation, as considerable heat is produced.

The lower shoe is permanently and rigidly secured in the lower half of the cylinder by means of dowel pins, or the like, such as indicated at 18. A permanent connection can

accordingly be made between the water-jacket of the lower shoe and the pipes, 16ª and 17ª.

The upper shoe, on the other hand, is mounted so as to float with relation to the grinding rotor, and a clearance is accordingly allowed between the upper surface of the shoe and the interior surface of the cylinder. This clearance, in actual practice, only amounts to a few thousandths of an inch, but it is nevertheless sufficient to permit the upper shoe to rise upwardly when the material to be ground is passing between the inner surface of the shoe and the exterior surface of the grinding rotor, as will hereinafter be described. Due to the fact that the upper shoe has a floating action, a slight clearance is allowed between the pipes 16 and 17 and the cylinder, as shown at 19, in Fig. 4, and stuffing boxes, such as shown at 20, are accordingly required, so that the pipes, 16 and 17, may freely rise or fall with the upper floating shoe.

Keyed or otherwise secured on the driving shaft 10, within the cylindrical extension 4, is a feed worm 21 and a breaker rotor 22. The material to be ground is delivered to the feed augur by means of a pipe, such as shown at 23. The material delivered is forced by the feed worm to the breaker rotor 22 and this, in turn, discharges the material into the cylinder proper through a series of holes or openings, such as indicated at 24.

The breaker rotor is best illustrated at Fig. 8. From this view it will be noted that the exterior surface of the breaker rotor is provided with a series of spiral or helical shaped grooves which extend from end to end thereof. These grooves decrease in depth towards the discharge end and the material which is being advanced by the breaker rotor will accordingly be subjected to greater and greater pressure before it is finally discharged through the openings 24 into the cylinder proper.

The feeding capacity of the worm 21 is greater than the capacity of the breaker rotor 22. This excess feeding capacity, together with the fact that the helical grooves decrease in depth towards the discharge end, causes the material to be subjected to considerable pressure and also to a slipping action. The forward faces of the grooves are accordingly inclined, as indicated at 25, and the outer faces are flattened, as indicated at 26, so that as the material slips, a thin film is formed between the outer flat faces 26 and the inner surface of the cylinder 4; this film permitting slippage of the material and also subjecting the material to a rubbing or grinding action, and at the same time to pressure, as the clearance between the flat faces 26 and the interior diameter of the cylinder 4 is such as to allow a film formation of only two or three thousandths of an inch. It might here be stated that the several ingredients to be ground are roasted cracked cocoa beans, sugar, cocoa butter, milk, etc. The cracked cocoa beans, may consist of pieces as large as a quarter of an inch, and these pieces must be broken down and finely ground and intermixed with the sugar and the milk and the cocoa butter to finally produce chocolate. The cocoa butter produces a substantially fluid-like mixture, which carries the cracked cocoa beans, sugar, and milk in suspension, the whole mixture having a consistency perhaps a little thinner than ordinary table syrup. At least it is sufficiently thin to flow by gravity or slight pressure through the pipe 23 into the feed worm 21. This worm, as previously stated, delivers the mixed ingredients to the breaker rotor 22. The spiral or helical projections formed on the exterior surface of the breaker rotor serves several functions: first, that of assisting the feed worm in advancing the material to the cylinder proper and second, that of breaking up the sugar and cracked cocoa beans to a comparatively fine, granular condition before delivery to the cylinder. It is for this reason that the rotor 22 is referred to as the breaker rotor, as it accomplishes the functions of reducing the comparatively coarse ingredients to a fine, plastic mass.

The inner end of the rotor 22 is provided with a cam-like projection 22ª. The material discharging from the breaker rotor enters an annular space, 24ª. The cam-like projection 22ª engages this material and forces it through the openings 24 into the cylinder, thus completing the first step of the grinding operation, to-wit: that of crushing or breaking up the comparatively coarse particles.

The grinding operation in this instance takes place in three steps. The first step already described being that which is accomplished by the breaker rotor; the second step is accomplished by means of a floating, grinding disc, generally indicated at 30. This disc is free with relation to the driving shaft 10 to the extent that it is freely movable longitudinally thereof. On the other hand it is caused to rotate in unison with the shaft 10 and the main grinding rotor 11, as one or more dowels, such as indicated at 31, forms a driving connection between the grinding disc and the rotor.

The outer face of the grinding disc 30 is best illustrated in Figs. 1 and 3. It is provided with a series of annular raised rings 32 and a series of intermediate annular ring shaped grooves 33. The faces of the rings 32 are provided with teeth 34 having the shape illustrated in Fig. 5, these teeth being tangentially disposed, as shown in Fig. 3. The inner face of the cylinder head 3 is similarly provided with annular aligning rings 35 and grooves 36. The rings 32 and 35 opposing each other and similarly the

grooves 33 and 36. The outer faces of the rings 35 have teeth formed therein, such as indicated at 37 and these teeth cooperate with the teeth 34, the teeth, 34 and 37, being substantially identical in shape and general structure as diagrammatically illustrated in Fig. 5.

The material which has been subject to a preliminary breaking and grinding action between the breaker rotor 22 and the inner face of the cylinder 4, which is discharged into the cylinder through the openings 24, are subjected to the second step of the grinding action by passing between the grinding disc 30 and the inner face of the cylinder head 3. The material is first delivered to the innermost groove, indicated at 38, and here accumulates until the groove is completely filled and is then discharged under pressure through holes 39, which delivers the material between the first set of cooperating grinding teeth formed on the cooperating surfaces of the innermost rings, indicated at 40 and 41. After the material has been subjected to the grinding and rubbing action of the teeth formed on the two innermost rings, indicated at 40 and 41, it discharges into the next annular and concentric groove indicated at 42, and it is here discharged between the next set of cooperating grinding teeth and discharges therefrom into the annular recess formed by the grooves 33 and 36. From these grooves it is delivered to a point between the grinding teeth formed between the cylinder surface and the outermost ring 32, and is finally discharged therefrom into the annular space, indicated at 43. This completes the second step of the grinding operation, but before proceeding further with the description it is thought that the specific shape and functions of the grinding teeth employed should be more fully described.

By referring to Figs. 1 and 5, it will be noted that the teeth formed on the inner surface of the head member 3 are stationary and that the opposing teeth formed in the rings of the grinding disc 30 are continuously rotating or moving. The stationary teeth are indicated at 37 in Fig. 5 and the rotating or moving teeth at 34, the direction of the moving teeth being indicated by the arrow *a*. Both the stationary and the movable teeth are identical in shape and construction. Each tooth represents a vertical face 44, an inclined face 45, and a flat face 46. As the material to be ground is delivered between the teeth, it enters wedge-shaped pockets, generally indicated at 47, and as the pockets 47 in one surface are stationary and the pockets 47^a in the opposite surface are continuously moving, it might be said that the material delivered to the wedge-shaped pockets is gradually pulled out into a thin film and then rubbed out between the cooperating flat surfaces, 46 and 46^a. This operation of pulling the material out into a thin film and then subjecting it to a rubbing action between the flat surfaces, 46 and 46^a is, of course, repeated a great number of times between each set of teeth, and it is accordingly possible that each solid particle is subjected to a rubbing action several thousand times before it finally discharges into the annular space indicated at 43. And it might further be stated that as each solid particle is subjected to this rubbing action again and again, it is gradually reduced in diameter.

It might also be noted in this part of the description that the vertical faces, 44, of the stationary and the movable grinding teeth, are always moving away from each other and that the wedge-like faces, 45 and 45^a, are moving toward each other. The first statement, to-wit: that the vertical faces are moving away from each other, is important, as it avoids any shearing action between the teeth and furthermore prevents, or at least reduces any dulling action of the points of the teeth, indicated at 48 and 48^a.

The second statement, to-wit: that the wedge-like faces 45 and 45^a are continuously moving toward each other, is also important, as it is this movement or action which is depended upon to pull out the material into the form of a thin film, which is rubbed and subjected to considerable pressure while passing between the flat cooperating surfaces, indicated at 46 and 46^a.

The third step and the final step of the grinding action takes place between the exterior surface of the main rotary grinder, indicated at 11, and the inner surfaces of the shoes, 12 and 13. Grinding teeth, identical in shape to those illustrated in Fig. 5, are formed in the exterior surface of the main grinding rotor 11 and similarly in the inner surface of the shoes, 12 and 13, the only difference being that the teeth formed on the outer surface of the main grinding rotor are helically arranged with an exceedingly high pitch. That is, each tooth extends from end to end of the cylinder and the helical advance is, if anything, less than 180 degrees of a complete circle. The teeth formed on the inner surfaces of the shoes, 12 and 13, are similarly helically arranged, and the pitch or advance of each helical tooth is substantially the same as that of the teeth on the surface of the main grinding cylinder. The material discharging from the second step of the grinding operation into the annular chamber (43) and which is to be subjected to the final or third grinding operation, enters the space formed between the shoes and the main grinding rotor at the point indicated at 50. It advances along the exterior surface of the main grinding rotor in the direction of arrow *b*, see Fig. 1, that is, between the exterior surface of the main grinding rotor and the inner surfaces of the shoes 12 and

13, and finally discharges into an impeller indicated at 51. This, in turn, discharges the material into a pipe 52, which may return the material to the pipe 23 if re-grinding is desired, and if re-grinding is not desired, it may be discharged from pipe 52 as a completed product.

Due to the high pitch of the helical grooves and teeth formed in the exterior surface of the rotor 11, and the inner surfaces of the shoes, 12 and 13, advance of the material is comparatively slow. Slippage or transfer of the material from groove to groove, or from tooth to tooth, on the other hand, is great, and the material is accordingly pulled out to a thin film and subjected to a rubbing action time and again before it is finally discharged by the impeller, indicated at 51. This is due to the fact that the teeth employed are identical to the teeth shown in Fig. 5 and the material is accordingly subjected to the same action, to-wit: that of being pulled out into a thin film by means of the inclined cooperating faces, 45 and 45a, and second, of being subjected to a rubbing action while in the state of film between the cooperating flat faces, indicated at 46 and 46a.

In actual practice, it has been found that a slight clearance is preferable in the bearings, 5 and 9, so that the shaft 10, together with the main grinding rotor 11, carried thereby, may rise to a slight degree when a film of material is being formed between the lower shoe and the exterior surface of the main grinding rotor. To this extent it may be said that the main grinding rotor, together with the upper shoe 13 has a floating action. The material being ground during the last and final step of the grinding operation is accordingly not only subjected to the actual weight of the shaft 10 and the main grinding rotor 11, but also to the weight of the upper shoe 13 and the circulating water passing therethrough. This weight is considerable and the efficiency of the rubbing or grinding action produced between the cooperating flat faces, 46 and 46a, of the grinding teeth is accordingly materially increased, and it is due to the pressure exerted and the numerous rubbing and grinding actions to which the material is subjected that an exceedingly finely ground material is finally obtained. That is, material which in actual practice is reduced to what might be termed a colloidal or a molecular state.

By referring to Fig. 1 it will be noticed that a thrust bearing 60 of the anti-friction type is carried by the end of the shaft 10 and that a helical compression spring 61 is interposed between this thrust bearing and the inner end of the adjusting screw 8. This is also an important feature as by increasing or decreasing the tension of the spring 61, the pressure between the faces of the grinding disc 30 and the cylinder head 3 may be varied and the fineness of the material discharging from the second step of the grinding operation may accordingly, to a certain extent, be controlled.

By referring to Figs. 1 and 6, it was stated that the teeth formed in the exterior surface of the main grinding rotor and on the inner surface of the shoes, 12 and 13, were helically arranged.

In Fig. 7 a modification is shown in which 70 indicates the cylinder, 71 the upper shoe, 72 the main grinding rotor, 73 the grinding disc, 74 the cylinder head and 75 the main drive shaft. The structure disclosed is identical to that shown in Fig. 1, with the exception that the grinding teeth are formed in the outer surfaces of a series of interspaced rings, such as indicated at 76, these rings and the grooves 77, formed between the same being identical to the rings and grooves formed on the disc 73.

I wish it understood that similar modification or changes may be resorted to within the scope of the appended claims, I similarly wish it understood that the material and finish of the several parts employed may be such as the experience and judgment of the manufacturer may dictate or various uses may demand.

While the present machine has been described as a chocolate grinding machine, I wish it understood that it may also be employed for grinding color pigments with oil. For instance, when manufacturing paints. And that it may also be used in the ink manufacturing business and in other arts where fine grinding of solids and semi-solids is essential.

What I claim and desire to secure by Letters Patent is:

1. In a grinding machine of the character described a cylinder, a drive shaft extending through the cylinder, a grinding rotor secured on the shaft within the cylinder, a grinding shoe interposed between the grinding rotor and the lower half of the cylinder, a second grinding shoe interposed between the cylinder and the upper half of the grinding rotor, grinding teeth formed in the adjacent surfaces of the shoes and the grinding rotor, and means for introducing material to be ground between the shoes and the grinding rotor.

2. In a grinding machine of the character described a cylinder, a drive shaft extending through the cylinder, a grinding rotor secured on the shaft within the cylinder, a grinding shoe interposed between the grinding rotor and the lower half of the cylinder, a second grinding shoe interposed between the cylinder and the upper half of the grinding rotor, grinding teeth formed in the adjacent surfaces of the shoes and the grinding rotor, means for introducing material to be ground between the shoes and the grind-

ing rotor, journal members supporting the drive shaft and the grinding rotor, said journals having sufficient clearance to permit floating movement of the grinding rotor with relation to the lower shoe, and means permitting floating movement of the upper shoe with relation to the grinding rotor.

3. In a grinding machine of the character described a cylinder, a drive shaft extending through the cylinder, a grinding rotor secured on the shaft within the cylinder, a grinding shoe interposed between the grinding rotor and the lower half of the cylinder, a second grinding shoe interposed between the cylinder and the upper half of the grinding rotor, grinding teeth formed in the adjacent surfaces of the shoes and the grinding rotor, journal members supporting the drive shaft and the grinding rotor, said journals having sufficient clearance to permit floating movement of the grinding rotor with relation to the lower shoe, means permitting floating movement of the upper shoe with relation to the grinding rotor, and means for introducing material to be ground under pressure into the cylinder.

4. In a grinding machine of the character described a cylinder, a drive shaft extending through the cylinder, a grinding rotor secured on the shaft within the cylinder, a grinding shoe interposed between the grinding rotor and the lower half of the cylinder, a second grinding shoe interposed between the cylinder and the upper half of the grinding rotor, grinding teeth formed in the adjacent surfaces of the shoes and the grinding rotor, journal members supporting the drive shaft and the grinding rotor, said journals having sufficient clearance to permit floating movement of the grinding rotor with relation to the lower shoe, means permitting floating movement of the upper shoe with relation to the grinding rotor, means for introducing material to be ground under pressure into the cylinder, and means whereby the introduced material is subjected to preliminary grinding action before passing between the grinding rotor and the shoes.

5. In a grinding machine of the character described a cylinder, a drive shaft extending through the cylinder, a grinding rotor secured on the shaft within the cylinder, a grinding shoe interposed between the grinding rotor and the lower half of the cylinder, a second grinding shoe interposed between the cylinder and the upper half of the grinding rotor, grinding teeth formed in the adjacent surfaces of the shoes and the grinding rotor, journal members supporting the drive shaft and the grinding rotor, said journals having sufficient clearance to permit floating movement of the grinding rotor with relation to the lower shoe, means permitting floating movement of the upper shoe with relation to the grinding rotor, means for introducing material to be ground under pressure into the cylinder; means whereby the material introduced is subjected to a breaking action and means whereby the material is subjected to preliminary grinding action after the breaker action and before introducing to the grinding rotor and the cooperating shoes.

6. In a grinding machine of the character described a cylinder, a drive shaft extending through the cylinder, a grinding rotor secured on the shaft within the cylinder, a grinding shoe interposed between the grinding rotor and the lower half of the cylinder, a second grinding shoe interposed between the cylinder and the upper half of the grinding rotor, grinding teeth formed in the adjacent surfaces of the shoes and the grinding rotor, a head member of each end of the cylinder, bearing members in said heads in which the drive shaft is journaled, grinding teeth formed on the inner face of one of the cylinder heads; a disc interposed between said cylinder head and one end of the grinding rotor; grinding teeth formed on said disc adapted to cooperate with the teeth in the cylinder head, a cylinder extension on said head through which the shaft extends; a feed worm secured on the drive shaft within the cylinder and a breaker worm also secured on the shaft and interposed between the feed worm and the disc.

7. In a grinding machine of the character described a cylinder, a drive shaft extending through the cylinder, a grinding rotor secured on the shaft within the cylinder, a grinding shoe interposed between the grinding rotor and the lower half of the cylinder, a second grinding shoe interposed between the cylinder and the upper half of the grinding rotor, grinding teeth formed in the adjacent surfaces of the shoes and the grinding rotor, a head member of each end of the cylinder, bearing members in said heads in which the drive shaft is journaled, grinding teeth formed on the inner face of one of the cylinder heads; a disc interposed between said cylinder head and one end of the grinding rotor; grinding teeth formed on said disc adapted to cooperate with the teeth in the cylinder head, a cylinder extension on said head through which the shaft extends; a feed worm scured on the drive shaft within the cylinder and a breaker worm also secured on the shaft and interposed between the feed worm and the disc, means for exerting pressure on the disc and means for delivering material to be ground to the feed worm.

8. In a grinding machine of the character described a cylinder, a drive shaft extending through the cylinder, a grinding rotor secured on the shaft within the cylinder, grinding teeth formed on the face of the cylinder,

cooperating grinding teeth disposed on the lower half of the cylinder, a grinding shoe interposed between the cylinder and the upper half of the grinding rotor, said shoe having teeth formed thereon cooperating with the teeth on the grinding rotor, and means for introducing material to be ground between the shoe, the cylinder and the grinding rotor.

9. In a grinding machine of the character described a cylinder, a drive shaft extending through the cylinder, a grinding rotor secured on the shaft within the cylinder, grinding teeth formed on the face of the cylinder, cooperating grinding teeth disposed on the lower half of the cylinder, a grinding shoe interposed between the cylinder and the upper half of the grinding rotor, said shoe having teeth formed thereon cooperating with the teeth on the grinding rotor, means for introducing material to be ground between the shoe, the cylinder and the grinding rotor, and means permitting floating movement of the shoe with relation to the grinding rotor.

10. In a grinding machine of the character described a cylinder, a drive shaft extending through the cylinder, a grinding rotor secured on the shaft within the cylinder, grinding teeth formed on the face of the cylinder, cooperating grinding teeth disposed on the lower half of the cylinder, a grinding shoe interposed between the cylinder and the upper half of the grinding rotor, said shoe having teeth formed thereon cooperating with the teeth on the grinding rotor, means for introducing material to be ground between the shoe, the cylinder and the grinding rotor, and means permitting floating movement of the shoe and the grinding rotor with relation to the lower half of the cylinder.

11. In a grinding machine of the character described the combination with a cylinder and the grinding members disposed within the same, of means for introducing material to be ground under pressure into the cylinder, means whereby the introduced material is subjected to a preliminary grinding action before entering the cylinder, said means comprising a head member on one end of the cylinder, grinding teeth formed on the inner face of the head, a disc interposed between said cylinder head and the grinding rotor, and grinding teeth formed on said disc adapted to cooperate with the teeth on the cylinder head.

12. In a grinding machine of the character described the combination with a cylinder and the grinding members disposed within the cylinder, of means for introducing material under pressure into the cylinder, means for subjecting the material to a preliminary grinding action, said means comprising a head on the cylinder, a plurality of concentric interspaced circles of grinding teeth formed on the inner face of the cylinder head, a disc adjacent the cylinder head and within the cylinder, said disc having a plurality of concentric interspaced rings of cooperating grinding teeth formed thereon, and means whereby the material receiving the preliminary grinding is delivered between the teeth, said means comprising a plurality of conduits extending from the bottom of the spaces formed between each ring of teeth to the faces of the teeth.

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