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2,903,197

MILLS, PARTICULARLY GRANULATING AND COLLOID MILLS

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2 Sheets-Sheet 1

FIG. 1

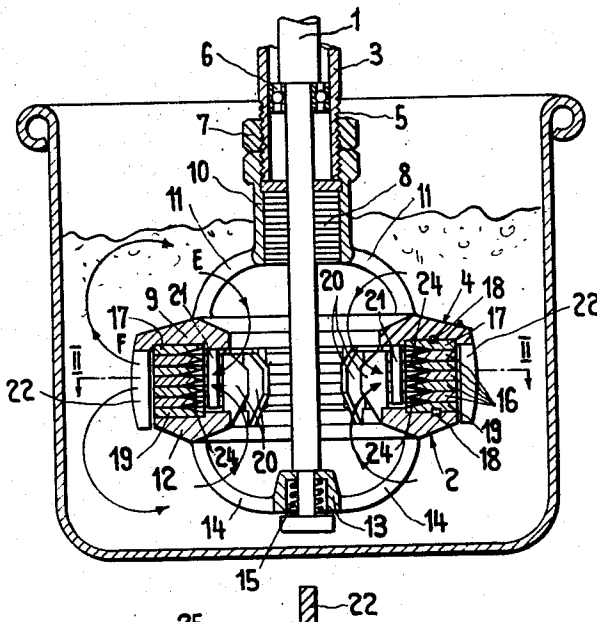
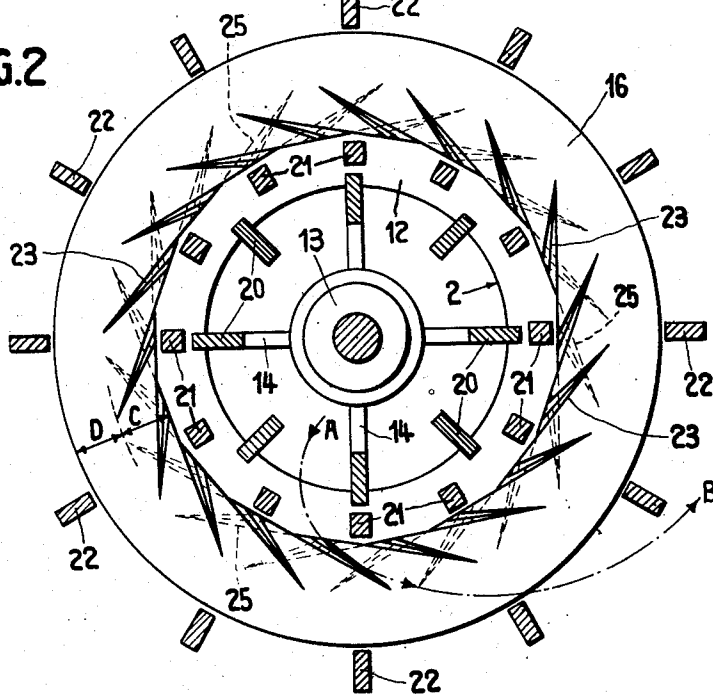


FIG. 2



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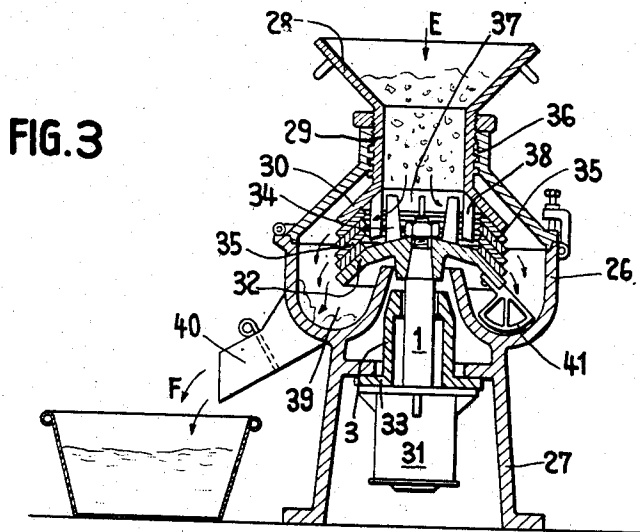
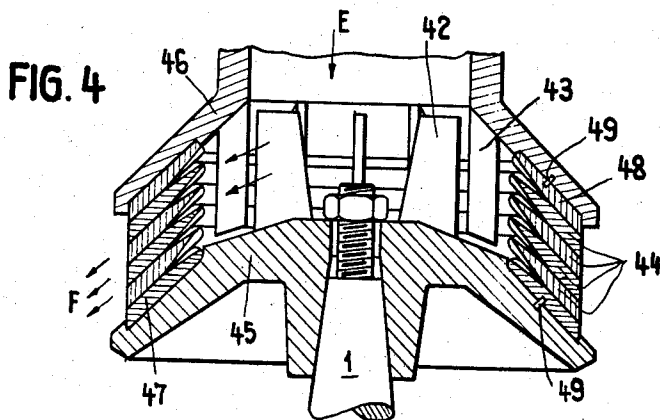
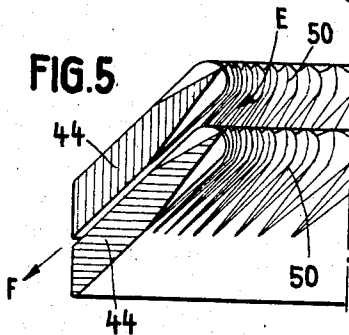
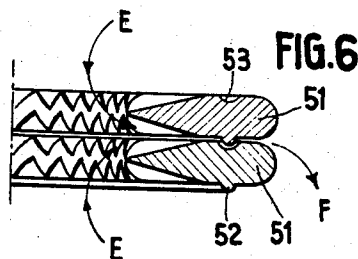
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MILLS, PARTICULARLY GRANULATING AND COLLOID MILLS

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2 Sheets-Sheet 2



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MILLS, PARTICULARLY GRANULATING AND COLLOID MILLS

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15 Claims. (Cl. 241—146)

The invention relates to a mill, for instance, for the production of dispersions, mixtures, emulsions and solutions, as well as for the grinding of solid, for example, dry substances.

More particularly, the invention relates to a mill having grinding discs or plates movable in relation to each other, with the reciprocal pressure and clearance of the grinding discs being regulatable when desired, and wherein rotating grinding discs or plates disposed coaxially to one another preferably are used.

It is true that known grinding mills, in which the material to be treated, for example, a crude mixture, passes through the gap formed between two discs, furnish a final product having a high degree of fineness. In view of the narrow gap and the shortness of the grinding surface, however, their production rate is small. If a larger output were required from them, uneconomic dimensions would be necessary. In addition, the narrow gap causes high power consumption and a low speed of rotation.

Although it has already been attempted to avoid larger dimensions by a higher speed of rotation, the increase in production obtained thereby was unsatisfactory because the narrow gap is basically opposed to the high production required.

This disadvantage of grinding mills has in many cases led to their displacement, for example, by rolling mills, which however do not possess some of the advantages of the grinding mills.

The present invention removes the above-described disadvantages of known grinding mills by increasing the quantitative output while the qualitative performance at least remains the same. With the mill according to the invention there are provided between two outer grinding discs which, for example, are carried by a rotor and a stator, one or more additional or intermediate grinding discs, which have grinding surfaces on both sides and which are rotatable in relation to the outer discs. By means of such intermediate discs, the number of grinding gaps between the outer discs increases by one for each additional disc inserted therebetween, so that, for example, with one intermediate disc two gaps are formed, with two intermediate discs three gaps are formed and so on. Since each additional gap gives the same output as the single gap between rotor and stator discs in the previously known grinding mills, the output of the mill is multiplied by the number of grinding gaps.

The known grinding mills are also sometimes provided with means for feeding the raw material between the grinding discs, such as propellers or blades, for instance, because the often very irregular material can lead to stoppage or congestion in the supply. However, these propeller-like devices frequently have no disintegrating effect on the raw material, or in any case only a very small disintegrating effect. Since the raw material however in many cases contains lumps, and often hard agglomerates, it is necessary to disintegrate such agglom-

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erates sufficiently before they arrive at the grinding gap to enable them to enter completely into the gap.

In the case of the mill according to the invention this previous comminution can, if desired, be obtained by building in a dispersing device, such as one according to Swiss Patent No. 288,154 or U.S.A. Patent No. 2,619,330. The material set in rapid rotary movement by the rotor of the dispersing device is suddenly braked or halted, whereby breaking up on collision and shearing between the sides and edges of the rotor blades and the stator blades of the dispersing device take place at the same time.

By reason of the pressure of the feed, the largely pre-comminuted and homogenised crude mixture or other material now arrives in the gap between the grinding discs, where it is pulverized by a grinding operation comparable to that of a mortar while being transported in a spirally-shaped flow towards the periphery of the grinding discs and there thrown out of the grinding gaps.

The fineness of the end product is determined by the distance from one another of the grinding discs, and consequently by the width of the gap as well as by the shape of the grinding surfaces of the discs. In order to regulate the degree of fineness, one outer disc, for example a stator, may be moved axially towards the other outer disc, for example the rotor, by means of screw threads, adjusting slots, or the like, so that the individual gaps between the grinding discs can be diminished or enlarged as the occasion demands. The width of the gap can thereby be reduced to zero, to obstruct the passage of any more material through the grinding mill.

In order to obtain a fineness of one micron, for example, the width of the grinding gap must be set theoretically at least at one micron. In practice, however, as a rule a wider gap has to be set than the desired maximum size of the particle of the end product which is required, since in addition to the direct grinding by the surfaces of the discs the friction between the particles of material also generally actively participates in the disintegration.

The disintegration process between the individual discs takes place in such a way that the material pressed in between the grinding discs is ground by the discs and at the same time is carried towards the periphery. In the case of this grinding operation, a characteristic advantage is shown by the grinding mill according to the invention which operates, first of all, as a hammer and cutting mill at the speed of the rotor shaft, and then as a grinding mill operating at a reduced speed. If the rotor is driven with a speed of rotation of say 5000 revolutions a minute and the stator is stationary, this speed of rotation of the rotor in the case of, for example, four intermediate discs, is distributed to five grinding gaps, so that for each gap the relative grinding speed of the annular discs forming that particular gap is only 1000 revolutions a minute. This peculiarity of the mill according to the invention has the advantage that the rotor can be driven by the driving means now available, such as an electric motor, a turbine, or a mechanism with any required speed of rotation. The built-in dispersing and breaking-up device thus operates at the high speed of rotation of the rotor, and the available high speed of rotation of the rotor allows a larger number of intermediate discs to be used, while an economic and technically advantageous speed for the grinding operation in the grinding gaps is still obtained.

A further advantage of this arrangement is also that the speed, when desired, can be regulated downwards from a maximum (for example, by variable resistances, or regulating mechanism) until an optimum for the disintegrating operation is reached, since almost every raw material requires different standards of pressure and working speed.

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The grinding discs may consist of metal, natural or artificial stone, glass, moulded abrasive, rubber, plastics, and the like. They have an externally conical, or flat or other shape. They may be convex, fluted, squared and/or provided with projections, grooves, humps, knife edges, holes or other roughness defining configurations which promote the disintegration of the product. In this way, the above-described mill can be used for the production of other than extremely fine products, such as granular products, gravel or the like. With a suitable design for the grinding or milling discs, the mill according to the invention makes possible every kind of milling of wet or dry material with high efficiency and with high qualitative performance. Thus the grinding or milling discs can be provided with accurately calculated shearing or granulating projections, which allow the specific dimensions of the prepared product to be predetermined.

The mill according to the invention can be constructed for various purposes.

The mill according to the invention may be stationary or portable. In the latter case, it can be inserted in different containers and thus, for example, allow the treatment of small quantities of substances in experimental containers. Carrying out experiments with such small amounts with the known grinding mills had the disadvantage that the latter mostly retained such small experimental quantities.

The mill according to the invention can also be furnished with sieves for classifying the product, with devices for the introduction of additional substances, such as, for example for the addition of liquid to solid substances or to viscous masses, as well as emulsifiers, catalysts, dye-stuffs, binding agents, and the like. The sieves are advantageously placed below or around the rotor, so that the material on emergence from the grinding discs is sieved before it reaches the outlet. Devices for the introduction of additional substances may be, for example, tubes, which open into the center or in the vicinity of the center of the grinding discs and there deliver the additives to the raw material, such as a crude mixture, from whence the additives are immediately subjected to thorough distribution in the mixture.

The attached drawings shown by way of example some embodiments of the invention.

In the drawings:

Figure 1 is an axial sectional view of a first embodiment of the invention,

Figure 2 is a sectional view taken along the line II—II of Figure 1,

Figure 3 is an axial sectional view of another embodiment of the invention,

Figure 4 is an enlarged axial sectional view of a part of a further embodiment of the invention which differs from that of Figure 3 only in the shape of the grinding discs,

Figure 5 is a detail view of the discs of Figure 4 on a larger scale and in axial section, and

Figure 6 is a fragmentary axial sectional view of flat grinding discs in accordance with still another embodiment of the invention.

In the embodiment according to Figures 1 and 2, the driving shaft 1 of the rotor 2 is supported by a bearing 6 in a coaxial tube 3, which carries the stator 4 on its end by means of a screw thread 5. Rotation of the stator 4 around its axis on the screw thread 5 of the tube 3 causes enlargement or reduction respectively of the clearance between the rotor 2 and the stator 4. The position of the stator 4 on the tube 3 is secured by the lock nut 7. A packing 8 is provided in a sleeve 10 which is integral with the stator 4 and is internally threaded for engagement with the threads 5. This packing 8 prevents the entry of material into bearing tube 3 and can also safeguard against the outflow of material from pressure containers, when the apparatus is built in such containers. The stator 4 further includes a disc 9 which is joined to the

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stator sleeve 10 by means of several spokes 11. The rotor shaft 1 is coaxial with the disc 9 of the stator 4 and passes through the opening of the latter. The rotor 2 includes a disc 12 which is attached to the end of the rotor shaft 1 protruding from the stator 4 by means of a hub 13 and spokes 14. The hub 13 is movable on the rotor shaft 1 in an axial direction, and is urged axially relative to shaft 1 by a spring 15 acting in the direction of the stator 4. Annular outer grinding discs 17 and 19 are carried by the stator disc 9 and the rotor disc 12, respectively, in suitably shaped recesses where they are held by pins 18. The spring 15, by way of the hub 13, the spokes 14 and the rotor disc 12, urges the annular disc 19 against additional or intermediate grinding discs 16 placed loosely and rotatably between the discs 17 and 19.

Between the flat disc 17 of the stator 4 and the flat disc 19 of the rotor 2 lie the flat, loosely inserted rotatable intermediate grinding discs 16, the number of such intermediate discs and the character of their grinding surfaces being determined by the purpose for which the mill is intended. Instead of being flat, as shown in Figure 1, the grinding discs may also have conical, convex or arched, profiled or perforated cross-sections. The disc 12 carries on its inside margin several radially extending blades 20 of a dispersing or pre-comminuting apparatus which are attached concentrically to the disc 12 and rotate with it around the axis of the apparatus. The disc 9 carries on its inside rim another circular row of blades 21 of the dispersing apparatus, which remains stationary with the disc 9. Outside of and distributed around the circumference of the discs 16, there are axially extending blades or teeth 22 attached to the disc 9 and which keep all the annular intermediate discs in a concentric position.

In Figure 2 it will be seen that the grinding discs have inlet and driving grooves or keyways 23, running from the inner periphery towards the outer periphery of the discs 16, and terminating in sharpened points 24 intermediate the inner and outer peripheries. Other grooves 25 are situated on the side of the disc not seen in Figure 2 and represented by broken lines. The grooves 23 and 25 are oppositely inclined with respect to radii extending from the axis of rotation so that the entrance of the mixture or other material into the grooves is ensured. The arrow A in Figure 2 shows the entrance of the crude mixture into the grooves 23 and the arrow B shows the approximate path of flow of the mixture during the grinding between the grinding surfaces of the discs 16, 17 and 19. The distance C is the width of the part of the grinding surface occupied by grooves 23 and 25, while the distance D is the full width of the part of the annular grinding surface of the disc which is not broken by grooves.

The arrangement shown in Figures 1 and 2 can be portable or attached to a stand or a dependent apparatus, or, by means of the hollow shaft 3 and suitable connecting pieces, it may be temporarily or permanently fitted in a container wall. The apparatus is driven, for example, by means of an electric motor or a power transmission means (not shown), which is mounted on the upper end of the tube 3 and sets the central shaft 1 in rotation. Although the tube 3 is stationary and shaft 1 is rotated in the above described embodiment, it is apparent that the tube 3 and the shaft 1 could be rotated in opposite directions.

The stationary mill according to Figure 3 is built in a housing 26 with a pedestal 27. The housing has a feeding hopper 28, which can be replaced by a tube for continuous feeding or another feed device. The hopper 28 has a neck piece 29 which is externally threaded and mates with internal threads 36 of the housing, and which, at its lower end, carries a concentric conical stator 30 forming one of the outer grinding discs. The driving mechanism is formed by an electric motor 31 built in

the base or pedestal of the housing 26. The parts of the mill consisting of the motor 31, a driving shaft 1 and a rotor 32 which forms the other outer grinding disc are carried by a tube 3, in which the central shaft 1 rotates. The tube 3 has a flange 33, which is clamped between the housing 26 and the motor 31. The shaft 1 projects upwards into the chamber of the mill and, at its upper end, carries the rotor 32 which is formed with a conical annular grinding surface. The rotor 32 has a circularly arranged series of blades 34 forming part of a dispersing apparatus or impact mill and which extend axially into a feed chamber 37 defined by annular conical intermediate grinding discs 35 loosely rotatable between the parts 30 and 32. The conical discs 35 are fitted to the shape of the parts 30 and 32. By rotating the neck piece 29 in the screw thread 36 of the housing, the clearance between the stator 30 and the rotor 32 may be regulated, and hence also the pressure between the grinding surfaces of all the grinding discs.

Depending into the chamber 37 formed by the annular discs 35 from the lower end of the neck piece 29, there are blades or teeth 38 which are disposed at a small radial distance from the inner periphery of the loosely rotatable discs 35, and on rapid rotation of the rotor 32 and its blades 34, the latter cooperate with the blades 38 to form the dispersing apparatus or impact mill.

A collecting trough 39 for the finished product is defined by the housing 26 below the rotor 32 and extends around and concentric with the axis of the rotor. The material flowing into the collecting trough is discharge through a drain 40 or, when a continuous operation is desired, is led into a pipe line (not shown) or the like. For ensuring continuous discharge from the trough 39, an entraining mechanism 41 for the material is attached to the rotor 32.

In Figures 4 and 5, the arrows E and F represent the inflow and outflow of the crude mixture through the dispersing apparatus comprising the blades 42 and 43, and through the grinding gaps between the adjacent intermediate grinding discs 44. The latter are loosely disposed, and thus rotatable and axially displaceable, between the conical rotor 45 and the stator 46, and owing to their similar conical shape, fit on one another or nest concentric with the axis. They are pressed together by the rotor supported outer grinding disc 47 and the stator supported outer grinding disc 48. The disc 47 of the rotor and the disc 48 of the stator are advantageously fixed interchangeably, for example by means of pins 49, in recesses provided for them on the rotor 45 and the stator 46, respectively, as is shown in Figure 4. The annular discs 44 of Figures 4 and 5 differ from those of Figure 3 in that they have tapered or acuminate inner edges. As is shown particularly in Figure 5, the grinding discs have tapered points 50 which extend from the inner periphery up to about half of the width of the annular discs.

In the embodiment shown in Figure 6, the intermediate grinding discs 51 are linked together by means of a tongue 52 and groove 53 on their confronting surfaces. These interlocking grooves and tongues help to ensure the concentric relationship of the loosely arranged discs 51 during operation. They can also favorably affect the grinding action of the discs on the material, and discs having such interlocking grooves and tongues can have any profile, which is arched or curved according to the type of the material being treated.

In Figures 1, 3, 4, 5 and 6 the path of the raw material is indicated by arrows E at its entrance into the dispersing and grinding means and by arrows F at its exit.

Static electricity or electric current of various types and from various sources exerts physico-chemical effects, particularly on conducting substances in the case of sufficiently thin-walled layers, and also on non-con-

ducting or poorly-conducting material, and may in certain circumstances release desired effects. In the mill according to the invention the substance or mixture being treated can if desired be exposed to electrical action, the stator and rotor being connected in a circuit so that the electricity has to flow over the intermediate grinding discs through the material situated in the grinding gaps. In such an embodiment it is obvious that the rotor and its mounting and the stator and its housing must be electrically insulated from one another.

The use of the invention is not confined to the examples shown. On the contrary, other forms, other arrangements of the parts to each other, other housings or other pipe systems or the like may be chosen, and the rotational axis of the mill may be in any position, either vertical, as shown, or horizontal or oblique, as long as the principles according to the invention are still preserved.

What I claim is:

1. A mill, particularly a granulating and colloid mill, comprising two coaxial, spaced apart grinding discs, said two discs constituting outer grinding discs and being rotatable about their common axis relative to one another, means mounting at least one of the two outer discs for sliding in the axial direction relative to the other of said two outer discs, means to set the axial position of the slidable disc and thus to change the distance between the outer grinding discs, at least one intermediate grinding disc concentrically guided and axially interposed between said outer discs and radially overlapping the latter to form two grinding gaps between the intermediate disc and the inner face of each of the outer discs, and means for feeding material to be ground through said grinding gaps, the intermediate disc being floatingly mounted and free to move axially and rotationally so that the slidable outer disc can be axially adjusted to cause an outer disc which is rotated to frictionally communicate rotational movement about said axis to the intermediate disc.

2. The mill according to claim 1, wherein the successive discs overlap radially to the same extent so that the grinding gaps are of substantially uniform radial width.

3. The mill according to claim 1, wherein the outer and intermediate discs are substantially of the same diameter.

4. The mill according to claim 1, wherein the outer and intermediate discs are flat, and additional means are provided to confine the radial movement of said intermediate disc relative to said outer discs, thereby to secure axial alignment of the outer and intermediate discs.

5. The mill according to claim 1, wherein the outer and intermediate discs are of a truncated cone shape and nest in each other to ensure the coaxial relationship of said discs.

6. The mill according to claim 1, wherein said means mounting one of the outer discs for axial sliding relative to the other of the outer discs includes a first axially extending hollow member, a shaft rotatably supported within the hollow member and being axially fixed with respect to the latter to extend therethrough, a second axially extending hollow member carried by the first hollow member and being axially movable relative to the latter along said shaft, the shaft being connected at one end to a rotating means and carrying at its other end said rotated outer disc, the second hollow member carrying said one outer disc which is non-rotated, the non-rotated outer disc being axially adjustable together with the second hollow member relative to said first hollow member and the rotated outer disc on said shaft.

7. The mill according to claim 1, wherein said two outer discs are mounted on a stator and rotor, respectively, said outer and intermediate discs all having central openings, and wherein said means mounting one of

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the outer discs for axial sliding relative to the other of the outer discs includes a shaft extending axially through said central openings and being connected at one end to a rotating means, means at the other end of said shaft supporting said rotor, a first sleeve-like member surrounding and supporting the shaft, and a second sleeve-like member reciprocatingly mounted on the first sleeve-like member and carrying said stator.

8. The mill according to claim 7, wherein said means supporting the rotor includes a hub movably arranged on the shaft and forming the central part of the rotor which has annularly shaped spokes secured to the hub and supporting the rotor, a compression spring housed within the hub and normally urging the rotor toward the stator.

9. The mill according to claim 1, wherein the outer and intermediate grinding discs are of annular shape, at least some of the grinding discs having grooves in their adjacent surfaces, each groove extending from the inner circumference toward the outer circumference to a point between the circumferences.

10. The mill according to claim 9, wherein the grooves extend in directions which, with respect to the annular shape of the grinding discs, are inclined from both the tangential and radial directions.

11. The mill according to claim 1, wherein more than one intermediate grinding disc is provided between said outer discs, adjacent intermediate grinding discs having a circular tongue-and-groove joint therebetween.

12. The mill according to claim 1, wherein said outer discs are mounted on a stator and rotor, respectively, the outer and intermediate grinding discs being of annular shape, and further comprising cooperating means on said stator and rotor extending within the hollow central space of the annularly shaped discs toward each other for providing a material-precomminuting action.

13. The mill according to claim 12, wherein the precomminuting means of the rotor includes spaced apart blades extending radially, and the precomminuting means of the stator are toothlike.

14. A mill, particularly a granulating and colloid mill, comprising a stationary housing having an internally threaded neck piece, means for feeding material to be ground into said housing through said neck piece and having an externally threaded portion engaging the internal threads of the neck piece for axial adjustment relative to the latter in response to turning of said material feeding means relative to said housing, a rotatable

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shaft coaxial with said neck piece and extending into said housing, a motor for rotating said shaft, a stator and a rotor fixed to said portion of the material feeding means and to said shaft, respectively, two coaxial, spaced apart outer grinding discs within said housing fixed to said stator and rotor, respectively, so as to be normally stationary and rotated, respectively, with said normally stationary outer disc being axially adjusted relative to said normally rotated outer disc by said axial adjustment of the material feeding means with respect to said neck piece of the housing, and at least one intermediate grinding disc concentrically guided and axially interposed between said outer discs and in radially overlapping relation to the latter to form grinding gaps between the inner faces of said outer discs and the confronting faces of said intermediate disc, at least said stationary and intermediate grinding discs being of annular shape to permit the passage of the material to be ground from said feeding means through said gaps, said intermediate disc being floatingly mounted and free to move axially and rotationally so that the normally stationary outer disc can be axially adjusted to cause the frictional transmission of the rotation of said rotated outer disc to said intermediate disc.

15. A mill as in claim 14, further comprising cooperating means on said rotor and stator, respectively, extending axially toward each other within the central hollow space defined by said discs of annular shape and being operative to provide a pre-comminuting action on the material passing to said gaps.

References Cited in the file of this patent

UNITED STATES PATENTS

90,531	Halladay	May 29, 1869
109,542	O'Connor	Nov. 22, 1870
151,025	Hibsher	May 19, 1874
272,334	Schofield	Feb. 13, 1883
938,466	Ericsson	Nov. 2, 1909
1,135,017	Hiller	Apr. 13, 1915
1,483,742	Nicol	Feb. 12, 1924
1,962,462	Pudan	June 12, 1934
2,176,892	Dotzer	Oct. 24, 1939
2,437,147	Zwoyer	Mar. 2, 1948

FOREIGN PATENTS

19,762	Great Britain	Aug. 24, 1910
455,890	Great Britain	Oct. 29, 1936