March 20, 1956 E. W. SCHNEIDER 2,738,930

DISPERSION MACHINE WITH PRELIMINARY COMMINUTING SYSTEM AND A PLURALITY OF DISPERSION SYSTEMS OF DIFFERENT CONSTRUCTIONAL FORM

Filed Dec. 5, 1950 3 Sheets-Sheet 1

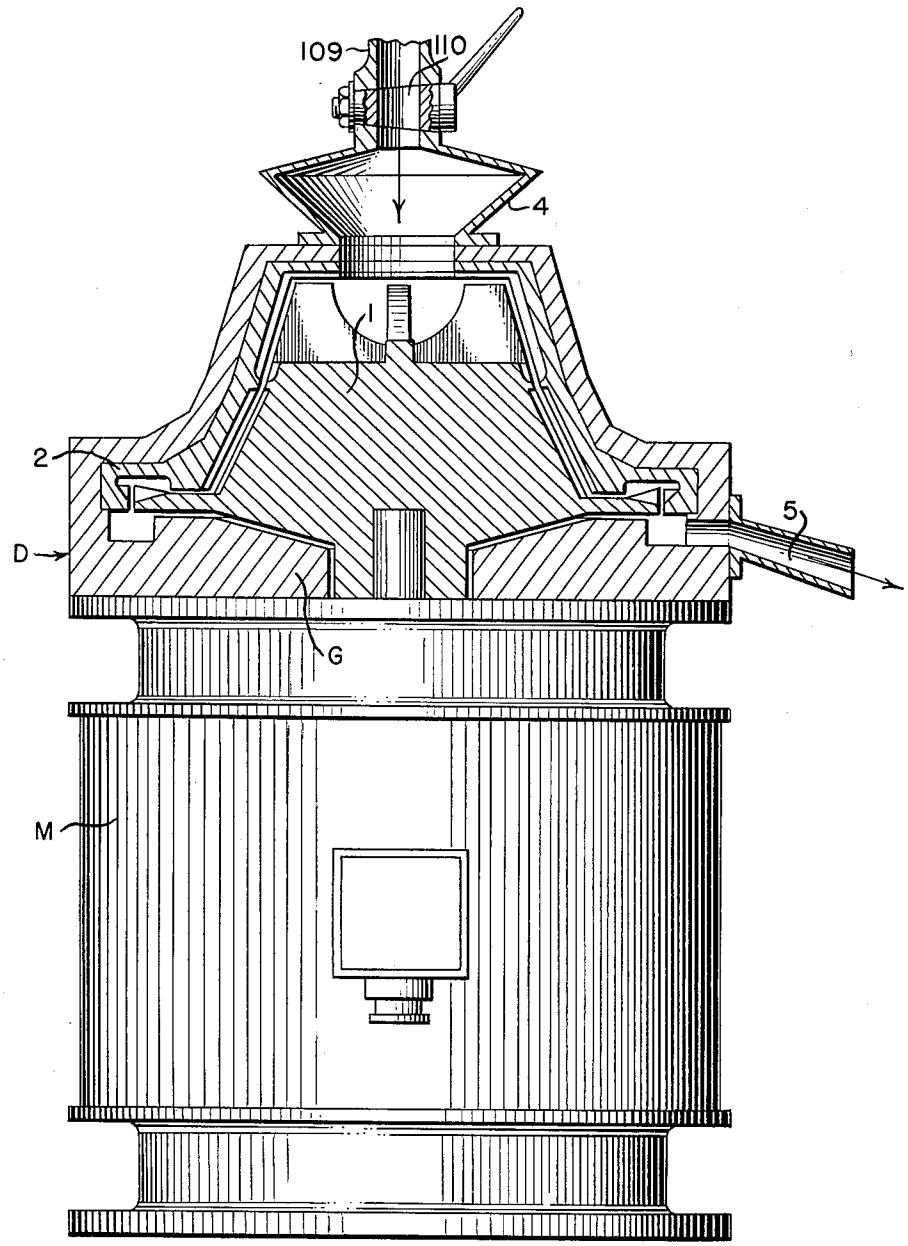


FIG. 1

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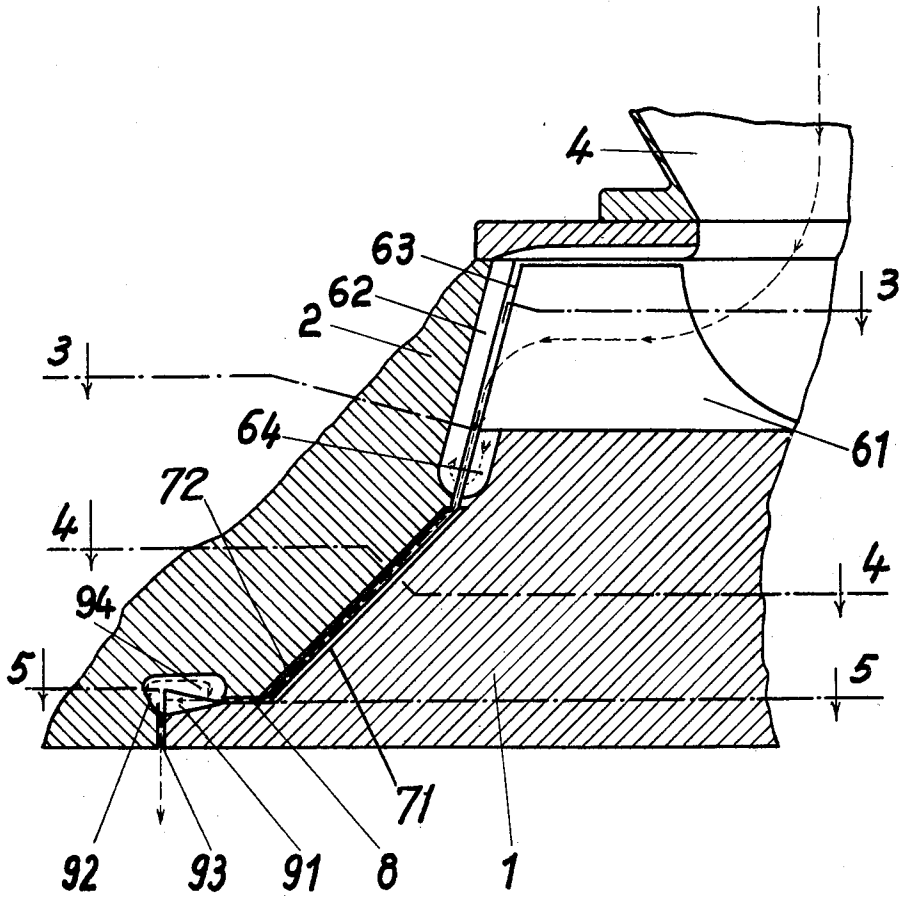
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Fig. 2



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Fig. 3

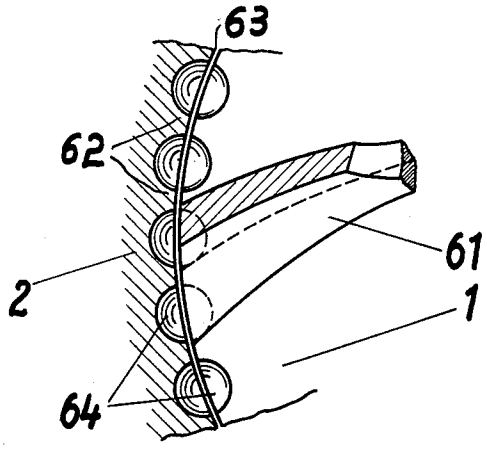


Fig. 4

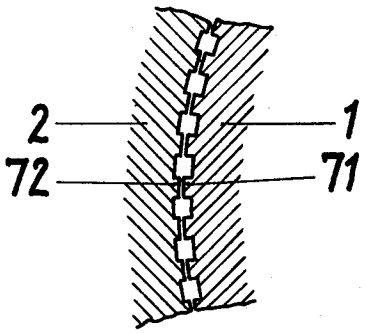
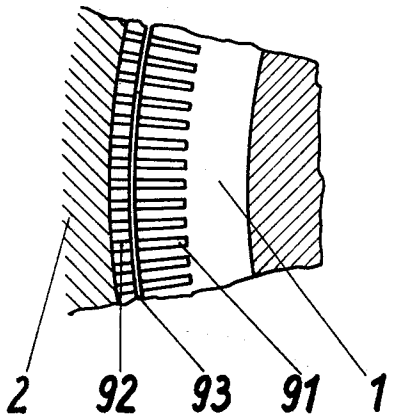


Fig. 5



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DISPERSION MACHINE WITH PRELIMINARY COMMINUTING SYSTEM AND A PLURALITY OF DISPERSION SYSTEMS OF DIFFERENT CONSTRUCTIONAL FORM

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10 Claims. (Cl. 241—162)

This invention relates to machines for the production of finely divided mixtures, such as emulsions, suspensions or dispersions.

The invention is directed more particularly to dispersion machines of the type of the so-called colloid mills, in which previously comminuted material is very finely divided in an appliance consisting of a toothed wheel which rotates at a high velocity in an internally toothed casing with only small clearance. The material to be operated on may be introduced in an already broken up state or in large pieces, in which latter case it is preliminarily treated in a preliminary comminuting machine which is built into the machine casing as a preliminary stage.

The primary object of the invention is the provision of an improved machine for the production of very finely divided mixtures, by which the material to be comminuted is divided up into minute particles of substantially the same order of magnitude.

A further object of the invention is to produce an improved very finely comminuting machine of such construction that the dividing up of the material to be comminuted into particles of a substantially equal, colloidal order of magnitude will be carried through with less expenditure of time and energy than has hitherto been possible with the known colloid mills.

A further object of the invention consists in creating an extremely fine dispersion machine of small constructional dimensions which requires relatively small driving energy, and which results in an extremely fine dispersion and is therefore suitable for use as a small machine.

In the sense of the objects of the invention, given above, and of further objects of the invention, which will be gathered from the specification and accompanying drawings, in which the invention is explained with reference to one constructional example, the main feature of the invention consists in this, that a plurality of dispersion systems of different constructional form and of different dividing effect are so arranged in the path of material under treatment, as it travels through the dispersion machine, that they are effective to divide up the material into particles of a magnitude which constantly decreases and at the same time becomes more uniform.

Further features of the invention and the advantages obtainable by them will be gathered from the following description in conjunction with the accompanying drawings, in which the invention is more particularly explained with reference to a preferred example. The invention is characterized in the accompanying claims.

In the drawings, in which the same or similar parts bear the same references,

Fig. 1 is a view in elevation, partly in section, of a comminuting machine according to the invention;

Fig. 2 is a fragmentary sectional view at an enlarged scale of the machine of Fig. 1; and

Figs. 3–5 are fragmentary plan sectional views taken on the lines 3—3, 4—4 and 5—5 of Fig. 2 respectively, Fig. 2 containing in addition a fragmentary perspective showing.

The minutely dispersing machine according to Fig. 1 comprises the driving motor M in the form of an ordinary upright motor and the dispersion device proper generally indicated at D, the casing G of which is fixed on the motor housing in the usual way, for instance by means of screw bolts. The rotor 1 of the dispersion device is coupled to the shaft of the motor M. In the casing G of the dispersion device an insert 2 is provided which acts as the carrier of the stationary part of the dispersing system or systems. On the upper side of the dispersion machine is the hopper 4 for the material to be treated, to which may be connected an inlet conduit 109 controlled by a valve 110. The hopper 4 is affixed over an aperture in the stator member 2 for admission of the material to be comminuted to the annular space or gap between the rotor and stator members of the machine. At the periphery of the casing G is the outlet conduit 5 for the finished product. In the constructional form according to Fig. 1 the rotor 1 rotates within the stationary part 2 of the dispersion system.

The dispersion device according to the invention will now be described in detail with reference to Figs. 2 to 5.

In the constructional form according to Figs. 1 to 5 the dispersion device comprises a preliminary comminuting system and two finely dispersing systems, which, including further operative means to be hereinafter described, are arranged in accordance with the invention one behind the other in the path travelled by the material. Both the preliminary comminuting system and the dispersion systems have rotating elements which are fixed to the rotor 1 and stationary elements which are fixed to the stationary part 2 or stator connected to the casing. The preliminary comminuting system comprises a system of symmetrically arranged radially extending teeth 61 on the rotor and teeth 62 on the casing part or stator 2, between the oppositely disposed working edges of which there is a working gap 63. The spaces between adjacent teeth 61 and between adjacent teeth 62 appear as slots in Fig. 3, of semicircular section in the particular embodiment illustrated. The working gap 63 extends with respect to the central axis of the dispersion machine obliquely downwards and outwards. Teeth 61 and 62 thus lie on coaxial surfaces of revolution which face each other across the gap 63 and which (or portions of which), within the tolerance of the width of the gap 63, conform substantially to a single or common surface of revolution having straight lines as generators—a conical frustum in the embodiment illustrated in the drawings. Below the preliminary comminuting system the working gap 63 widens into a system of cylindrical bores 64 which extend as to one half into the rotor and as to the other half into the stationary part 2 of the casing. Below the bores the gap 63 between rotor and stator first of all narrows again to its original width and then continues into the first dispersion system, its inclination away from the machine axis being increased. This first dispersion system comprises radially-symmetrically distributed teeth 71 and 72, the teeth 71 being on the outer peripheral surface of the rotor 1 and the teeth 72 on the facing inner surface of the casing part 2, teeth 71 and 72 being either fixed upon or formed integrally with the rotor 1 and stator 2. It will be seen from a comparison of Figs. 3 and 4 that the teeth 71 and 72 are more numerous than the teeth 61 and 62. As will be seen more particularly from Fig. 2, the facing edges of the two groups of teeth extend practically parallel to one another with a narrow space between them, which acts as the working gap between teeth 71 and 72. The teeth 71 and 72

also lie on coaxial surfaces of revolution which face each other across a narrow gap and, within the tolerance defined by the width of that gap, these surfaces conform substantially to a single surface of revolution having straight lines as generators, these generators being inclined to the axis of the machine by a larger angle than are the generators of the surfaces on which lie teeth **61** and **62**. The gap between teeth **71** and **72**, viewed in the peripheral direction, alternates in regular succession with enlarged spaces constituted by the gaps or slots between the teeth. Fig. 4 shows the position of the teeth **71** and **72** at the moment when the rotor teeth just coincide with the stator teeth.

Forming a continuation of the first dispersion system and particularly of the gap between teeth **71** and **72** is a narrow annular gap **8**, the axial plane of which is perpendicular to the machine axis and the wall surfaces of which have no operative comminuting or dispersing means.

This annular gap is followed by the second dispersion system. This system consists of an annular chamber **94**, the plane of the longitudinal axis of which is also practically perpendicular to the machine axis. Chamber **94** may be considered as an enlargement in the annular gap or space separating rotor and stator, this enlargement having a larger cross section than the portions of that space identified at **8** and **93** in Fig. 2 which precede and follow chamber **94** in the direction of flow of the material through the machine. The annular space of course extends between the inlet and outlet ends of the machine, i. e. it includes as well the gap **63** and the gap between the facing arrays of teeth **71** and **72**. The upper part of the annular chamber is also free of operative means. At the lower limit of the annular chamber are two coaxial systems or rings of teeth, of which one group or ring, comprising teeth **91**, is provided on the rotor and the other ring of teeth **92** is provided on the stationary casing part or stator **2**. The end edges of the two groups of teeth **91** and **92** extend, similarly as in the case of the groups of teeth **71** and **72**, parallel to one another, leaving a narrow working gap **93**. The working gap **93** extends parallel to the machine axis and continues in a straight line into a narrow annular gap between the rotor **1** and the casing part **2**, which gap terminates in the outlet conduit **5** (Fig. 1) for the finished material.

The fine dispersion machine according to Figs. 1 to 5 operates in the following manner: After the driving motor has been started up the material to be treated is delivered, while the rotor is rotating, into the hopper **4**. Under the combined influence of gravity and centrifugal force the material flows through the machine along the path indicated by the dashed arrow line of Fig. 2. The material to be treated passes first within range of the teeth **61** and **62** of the preliminary comminuting system. In this radially outward motion it strikes against the ends of the casing teeth **62**. At the same time the material is displaced tangentially by the rotor teeth **61**, so that in the area of the working gap **63** it is comminuted by the interaction of the rotor teeth **61** and stator teeth **62**, the particles becoming finer and finer. The cylindrical bores **64** of the preliminary comminuting machine act during this stage as a vortex chamber free of operative means, in which coarser particles are conveyed by rebound back into the preliminary comminuting system and are again subjected to the comminuting process. The material thus passes in a preliminarily comminuted state into the first dispersion system, where it is finely divided to a continuously increasing degree by the action of the teeth **71** and **72**.

The already finely divided material thereupon enters the annular gap **8**. This annular gap acts as a homogenising gap, such as is already known in dividing machines, more particularly in emulsifiers. In the present case, however, the annular gap **8** acts in a manner to be hereinafter described so as to raise the efficiency of the second dispersion system. The material entering this system is at first subjected, in a similar manner as in the first dispersion system, through the coaction of the tooth systems **91** and **92** to an increased comminuation. The coarser particles may strike the peripherally outer wall of chamber **94** between adjacent teeth **92** and are enabled to return via the smooth upper portion of chamber **94**, as indicated by the dashed arrow in Fig. 2, so as to be subjected to repeated comminution by teeth **91** and **92**. Consequently, the coarser particles are subjected in the interior of the second dispersion system to a much more frequent treatment than the finest particles which, as soon as they have reached the desired particle size, leave the system through the working gap **93** and its axial extension. Thus, the result is obtained in accordance with the invention that the size of particle of the finished material varies only within quite narrow limits.

The effectiveness of this second dispersion system is increased in the constructional form of the invention illustrated by the provision therein of the aforesaid radially inwardly opening material inlet or homogenising gap **8** for the material under treatment and of an outlet for the finished material commencing in the extension of the working gap **93**. It is thus clear that the circulating chamber **94** has at **8** an inlet which extends at an angle to the length of the teeth **71** and **72** and hence at an angle to the slots or slot chambers between them. Furthermore the outlet formed by the gap **93** from the circulating chamber is at an angle to the inlet into the circulating chamber. The resistance to flow of a particle suspended in the dispersion medium is in order of magnitude proportional to the square of its diameter, assuming a spherical particle, whereas the energy of motion of the particle increases with its mass and therefore with the cube of its diameter. Therefore the energy of motion will with an increase in the diameter of the particle increase more rapidly than its resistance to flow. Hence, coaser particles will be less ready to allow themselves to be deflected into a curve path, i. e. in the direction towards the material outlet, than fine particles which will follow the flow to the outlet, whilst the coarser particles will retain their radially outwardly directed motion longer, until they reach the internal back wall of the gaps between the teeth **92** in the casing and are consequently caused to circulate several times between the circulating chamber **94** and the slots between adjacent teeth **91** and **92** until they also are divided up into very small particles which can be carried along by the flow to the outlet.

Within the chamber **94** the breaking of the particles takes place not only between the teeth **91** and **92**, but also at the boundary zone between chamber **94** and the faces of teeth **91** and **92** presented thereto, where the material has an axial upward and downward motion imparted to it by those faces of the rotor teeth **91** and **92**.

It is already known in the art to pass the material repeatedly through a comminuating system. Hitherto, however, all the particles, therefore necessarily also those already having the prescribed size, were treated again. This involves an unnecessary expenditure of time and energy. In the above described second dispersion system there takes place an automatic separation of the finely dispersed particles from those which are still too large.

The very fine dispersion machines illustrated are shown with teeth extending in straight lines and along cone meridians, i. e. along the generators of the conical frusta to which the arrays of teeth **61**, **62**, **71** and **72** conform. It is also possible, however, to let the teeth run obliquely in opposition to one another or spirally. It is also possible to give the teeth on the rotor and on the stationary casing part dissimilar and/or oppositely directed pitches. In such machines a constant change and shifting of the narrow and wide parts of the working gap takes place, whereby the material, owing to its own inertia, is subjected to additional internal stresses.

The dispersion machines of the invention are in gen-

eral constructed of corrosion resisting and hard material, for instance of non-rusting steel or hard porcelain. It is however also possible, more particularly when dealing with a material consisting only of liquid phases, to use softer material, for instance artificial plastic, for some of or all the machine parts.

Owing to the small number and constructional simplicity of the parts, the very fine dispersing machines according to the invention can be made by mass production and more particularly by casting and pressing processes at low cost. It is also possible to provide the very fine dispersion machines according to the invention with exchangeable sets of parts which can be adapted to the desired output and/or the peculiarities of the particular material to be treated. Such machines are, for instance, as suitable as universal appliances for laboratories and the like.

A further advantage of the machines according to the invention is, that they will clean themselves, when fed with cleaning agents and the rotors are allowed to rotate.

I claim:

1. Apparatus for producing very finely divided mixtures such as dispersions, suspensions, emulsions or the like comprising rotor and stator members having cooperating facing surfaces, one of said members having at least one aperture therein through which material to be treated can be fed so that it can pass between said facing surfaces, said members further having a space therebetween, cooperating teeth on said surfaces constituting a working stage subjecting material to fine subdivision, means including an annular chamber formed in at least one of said members, said chamber being in communication with the space between said members, said chamber constituting a circulating chamber, an outlet communicating with said annular chamber, said outlet leading from said annular chamber angularly with respect to the space between said members at the communication of said space with said annular chamber, and a plurality of teeth on each of said members facing each other across said outlet, said last-named teeth having a face presented to said annular chamber.

2. Apparatus for producting very finely divided mixtures such as dispersions, suspensions, emulsions or the like comprising rotor and stator bodies having cooperating facing surfaces, said surfaces being spaced from one another to define a working gap through which material to be treated can pass, an aperture in one of said bodies constituting an inlet communicating with said working gap, said facing surfaces including a conical portion and teeth on the conical portion of each of said bodies constituting a first comminuting system for subjecting the material to a fine degree of subdivision, one of said bodies having an annular chamber therein communicating with said working gap, said bodies being spaced beyond said chamber to define a discharge slit, each of said bodies having formed thereon additional teeth presented to said chamber, said last mentioned teeth being arranged on opposite sides of the discharge slit, whereby material flowing from the inlet is subjected to a fine degree of comminution by the first mentioned teeth and flows into said chamber for additional comminution by the teeth therein, said annular chamber constituting a circulating chamber so that materials of coarse particle size can be circulated within said chamber between the teeth therein until their particle size is reduced so that all particles discharged through the discharge slit have substantially the same particle size.

3. In a dispersion machine, two relatively rotatable bodies, said bodies having coaxial surfaces facing each other with an intermediate narrow gap therebetween, a plurality of teeth on each of said bodies, said teeth facing each other across said gap, inlet means for the material to be comminuted in advance of and communicating with said gap on one side of said teeth, an annular chamber on one of said bodies communicating throughout its length with said gap on the side of said teeth opposite said inlet means, the portions of said gap on opposite sides of said chamber being angularly inclined to each other, and additional teeth on each of said bodies facing each other across said gap on the side of said chamber remote from said inlet means, said additional teeth having at least one face exposed to the interior of said chamber, said chamber constituting a circulating chamber in which the coarser particles of material to be comminuted circulate between the last-mentioned teeth.

4. A comminuting machine including a stator and a rotor supported for rotation within said stator, said rotor and stator including each a first portion and a second portion, said first portions both conforming substantially to frusta of a first single cone, said second portions both conforming substantially to frusta of a second single cone of larger half angle than said first cone, the bases of said first portions coinciding substantially with the tops of said second portions respectively, each of said first portions having formed therein a plurality of slots extending the slant height thereof and having a depth greater than the clearance between said first portions, each of said second portions having formed therein a plurality of slots extending the slant height thereof and having a depth greater than the clearance between said second portions, the slots in said second portions being more numerous than the slots in said first portions.

5. A comminuting machine comprising two relatively rotatable bodies, said bodies including each a first portion, said first portions both conforming substantially to frusta of a single cone, each of said bodies having a plurality of grooves therein extending the slant height of its first portion, the grooves in one of said bodies being parallel in pairs with the grooves in the other of said bodies, means to support said bodies for relative rotation with a gap therebetween and with close clearance between said first portions, said bodies being shaped adjacent the base of their first portions to provide in said gap an annular enlargement of greater cross sectional dimension than the clearance between said first portions, each of said bodies having a plurality of teeth thereon having a face exposed to said annular space, said teeth facing each other with close clearance across said gap on the side of said enlargement remote from said first portions.

6. A comminuting machine comprising a stator and a rotor, said stator having a first interior surface and said rotor having a first exterior surface, said first surfaces conforming substantially to a single frustum, each of said first surfaces having formed therein a plurality of slots extending from the top to the base of said frustum, and means supporting said rotor for rotation within said stator with a gap between rotor and stator and with said first rotor surface at a close clearance from said first stator surface, said rotor and stator being further shaped to define therebetween in said gap an annular enlargement adjacent one end of said frustum, said rotor and stator being further so shaped that the portions of said gap on opposite sides of said enlargement are angularly inclined to each other, each of said rotor and stator having an array of teeth, the teeth of said arrays facing each other with close clearance across said gap on the side of said enlargement remote from said first surfaces, said teeth being further exposed to the interior of said enlargement.

7. A comminuting machine comprising two relatively rotatable members and means to support said members for relative rotation, each of said members having a first surface conforming substantially to a single surface of revolution having straight lines as generators, said members having formed on said first surfaces a plurality of grooves parallel to the generators of said surface of revolution, said members further having surfaces defining an annular space between said members adjacent one end of said surface of revolution, said space having a cross

sectional dimension greater than the clearance between said first surfaces, each of said members having a plurality of teeth of which a face is presented to said space, the teeth of one of said members facing the teeth of the other of said members across the clearance between said members on the side of said space remote from said surface of revolution.

8. A comminuting machine comprising two relatively rotatable members and means to support said members for relative rotation one within the other and with a gap therebetween, one of said members having an inlet aperture communicating with said gap at one axial end thereof for the supply to the gap of a liquid suspension of material to be comminuted during passage through said gap axially of said machine to an outlet end of said gap at the axially opposite end thereof, each of said members having, facing each other across a portion of said gap, a first surface conforming substantially to a common surface of revolution having straight lines as generators, each of said first surfaces having formed therein a plurality of grooves extending lengthwise of said generators, said members being further shaped to define in said gap on the side of said first surfaces remote from said inlet aperture an enlarged annular space of greater cross sectional dimension than that of said gap on either side of said space, said members being so shaped that the trace, in planes containing the axis of relative rotation of said members, of the portions of said gap on the inlet and outlet sides of said space are angularly inclined to each other, and a plurality of teeth on each of said members, said teeth having at least one face presented to said space, those of said teeth on one of said members further facing those of said teeth on the other of said members across said gap on the outlet side of said space.

9. A comminuting machine comprising two relatively rotatable members, said members having each a first and a second surface, said first surfaces conforming substantially to portions of a first single surface of revolution having straight lines as generators, said second surfaces being coaxial with and joined to said first surfaces respectively, said second surfaces conforming substantially to portions of a second single surface of revolution having straight lines as generators, the generators of said second surface of revolution being inclined to those of said first surface of revolution, each of said members having formed in its said first surface a plurality of grooves extending lengthwise of the generators thereof, each of said members further having formed in its said second surface a plurality of grooves extending lengthwise of the generators thereof, the grooves in said second surfaces being more numerous than the grooves in said first surfaces, and means supporting said members for relative rotation with small clearances between said first surfaces respectively and between said second surfaces respectively.

10. A comminuting machine comprising a stator and a rotor supported for rotation within the stator, said rotor and stator including first surfaces conforming substantially to a frustum of a common cone and second surfaces coaxial with and joined to said first surfaces respectively, said second surfaces conforming substantially to a common surface of revolution whose generators are inclined to the axis of said cone by a larger angle than the half angle of said cone, each of said first surfaces having formed therein a plurality of grooves of substantially semicylindrical section extending lengthwise of the generators of said first surfaces, each of said second surfaces having formed therein a plurality of grooves extending lengthwise of the generators of said second surfaces, the grooves in said second surfaces being more numerous than those in said first surfaces.

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