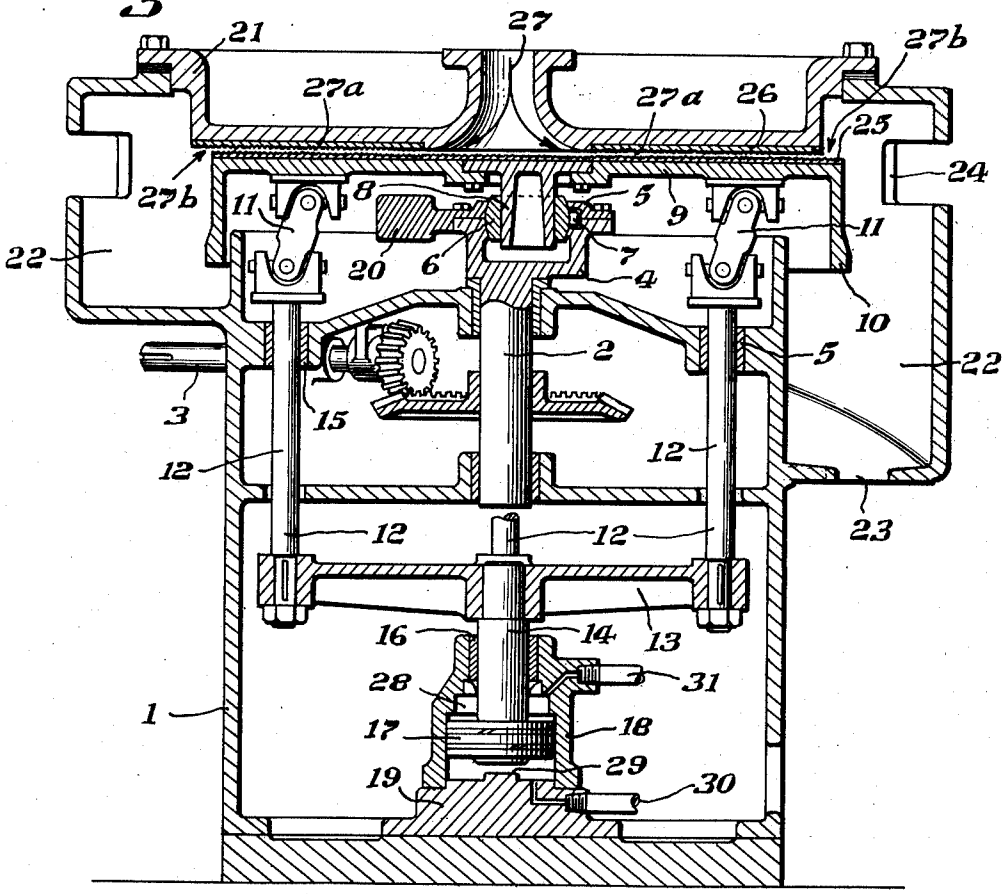
June 10, 1952 J. T. COGHILL ET AL 2,599,543

GYRATORY PROCESSING APPARATUS

Filed June 6, 1946

Fig. 1



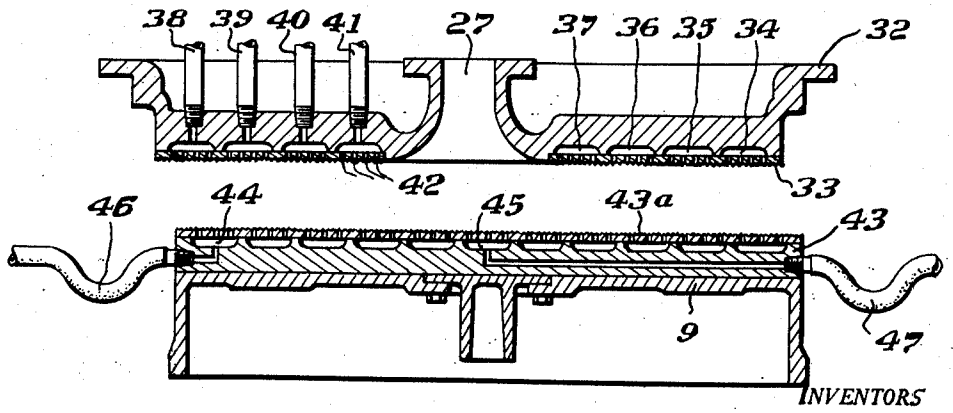


Fig. 2

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GYRATORY PROCESSING APPARATUS

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Application June 6, 1946, Serial No. 674,672

6 Claims. (Cl. 92—26)

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The present invention relates to a general utility processing apparatus which is partially disclosed in Hill & Edwards application, Serial No. 565,123, now Patent No. 2,516,384, granted July 25, 1950, and in our application Serial No. 674,671, filed June 6, 1946, which has now been abandoned, but is not claimed in these applications.

A principal object of our invention is to provide novel and particularly efficient apparatus suitable for the rapid and continuous performance of any of the following operations:

Rapid and uniform mixing of two or more substances.

Intense agitation of heterogeneous reaction mixtures as an aid in promoting greater efficiency and better control of a chemical reaction.

Rapid and efficient blending of liquid or solid agents with fibrous pulps at high consistencies.

Production of very uniform pastes, emulsions and suspensions.

Very efficient displacement washing of fibrous pulps at high consistencies.

Controlled and very rapid disintegration of friable and fibrous materials.

Other objects and advantages of our invention will be apparent from the following description, the accompanying drawings and the appended claims.

In the drawing which discloses a preferred embodiment of the invention:

Figure 1 is a view in vertical section of an apparatus constructed in accordance with this invention, and

Figure 2 is a view in cross section of a special adaptation of the working elements of our invention.

In broad terms we may describe our invention as comprising two opposed coacting elements having working surfaces which are disposed and adapted to engage therebetween a relatively thin layer of the material to be treated and which have a tractive surface texture effective to provide strong resistance to slipping on the material in contact, means for maintaining and controlling the clearance between the working surfaces, means for imparting to the surfaces relative tangential motion of a gyratory character, with one edge zone of the clearance between the surfaces adapted to permit continuous entry of untreated material and another edge zone adapted to allow continuous exit of the treated material. Various modifications and improvements of these basic provisions are included in our invention and will be described hereinafter.

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In our abandoned application Serial No. 674,671 we described types of apparatus sharing some of the above listed specifications, but specifically adapted to purposes of processing fibrous pulp and therefore having working surfaces adapted to supply the necessary traction, or resistance to slipping, to that particular class of material. We have found that a similar technique with modified apparatus may be adapted, with new and beneficial results, to a wide range of process operations where extremely rapid and thorough agitation is an object, it being particularly valuable and effective in cases where the nature and form of the process material are such as to render rapid, continuous agitation difficult or impossible by ordinary stirring means, as for example in the case of heterogeneous reaction systems of powdered or granular materials, or liquids and powders, or systems involving viscous liquids or fibrous materials. Obviously, the greatly intensified agitation thus provided may be taken advantage of for numerous applications, such as for obtaining greater efficiency, speed, and control of chemical reactions in difficultly agitatable systems, for efficient and rapid blending and compounding of materials of many classes, all in continuous pass through a compact apparatus. It is believed that the apparatus of the present invention provides an intensity, rapidity, and thoroughness of action which has not hitherto been available by any convenient means, and that this new action may ultimately find application, not only in a wide variety of existing processes, but also in new processes which may be based in part on the availability and advantages of the new action. It is not possible, therefore, to define, as is usually done, the specific field of usefulness of our invention.

Several inherent characteristics of the action produced by our invention may account for its unusual effectiveness. One is that the relatively gyrating surfaces in tractive contact with opposite sides of a relatively thin layer of material apply the working force throughout all the material under action with a very rapid and continual change in direction. Another is that, as a characteristic of gyratory motion as herein defined, no two points on a working surface relative to the opposed surface describe common paths in a full gyration cycle, thus insuring maximum crisscrossing of the paths of force and movement, and therefore the minimum of chance that any particle of the material can escape the force and movement in a single pass between the working surfaces.

The principal features of the apparatus of our

invention will be most readily understood from the following description of the preferred embodiment illustrated in the drawings.

Referring to Figure 1, the circular housing 1 supports central journals which carry the rotatably mounted driving axle 2. This axle is caused to rotate at the desired speed by means of bevel gears and an externally protruding driving shaft 3. The upper end of the driving axle 2 terminates in a circular cup 4 which is eccentric as related to the axis of rotation of the driving axle. The eccentric cup 4 in combination with the flange 5 bolted thereto provides an internal surface of spherical contour in which is fitted a journal bearing 6 having a protrusion 7 which, interlocking with a cavity in said flange, prevents rotation of journal 6 as related to flange 5, but permits moderate self-aligning motion.

The gyrating journal 8 is driven in a circular path having a radius equal to the eccentricity of the cup 4 and is provided with clearance space at both ends of the bearing 6 so that it may move or oscillate vertically a short distance, such as ¾ of an inch with reference to said bearing. The gyrating journal 8 is fastened to, as a part of, the circular gyrating element 9 which is supported vertically by four pairs of universal joints 11, two of which are shown in this illustration, the other two being in the alternate 90° positions. The upper end of each pair of universal joints is bolted to the gyrating element while the lower end is bolted to one of the connecting rods 12. These connecting rods are rigidly attached at their lower ends to the yoke 13 and the piston rod 14.

It will be seen that with each of the connecting rods 12 journaled for free vertical motion at the bearings 15 and with the piston rod 14 journaled for free vertical motion at the bearing 16, the combined structure of piston rod, yoke, and connecting rods comprises a unit free to move up and down vertically but in no other direction. The well known characteristics of the universal joints 11, which are customarily used to transmit rotation through misaligned shafts, are applied in the apparatus to prevent rotation of the gyrating element 9 and to control its vertical position as well as to apply pressure for treatment of material.

The piston rod 14 is connected to a piston 17 operating in the hydraulic or pneumatic cylinder 18, which is in turn mounted on cylinder head 19 and connected rigidly to the frame 1 through the common base of the apparatus.

It will be seen from the structure described above that when the driving axle 2 is rotated, the element 9 is gyrated in a circular path having a radius equal to the eccentricity between cup 4 and axle 2, but is prevented from rotation on its own axis by the universal joints so that all points on its surface travel in circular paths of equal diameter.

In order to prevent excess vibration of the machine, due to the weight of the gyrating parts, we extend an apron 10, downwardly from the rim of the gyrating element to bring the vertical center of gravity of the gyrating parts into a location where the centrifugal force of these parts can be counterbalanced by a rotating counterweight 20 which is a part of the flange 5.

This method of counterbalancing provides complete elimination of vibration for one selected vertical position of the gyrating element and approximate balancing for other vertical positions.

We use four universal joints for convenience of construction, but other numbers of universal joints may be used as long as they are so arranged as to provide adequate support of the gyrating element and hold it in a horizontal plane.

The housing 1 is extended to hold the stationary element 21. Other portions of the housing provide a channel 22 for the treated material so that it may flow or be transported to the outlet 23. Observation and access openings are provided at 24. It will be understood that other means to collect the treated material will be required in cases where the material being treated will not flow or when it is inadvisable to sluice it to a central discharge point with a liquid.

The gyrating working surface 25 and the stationary working surface 26 are attached to their respective elements 9 and 21 and from therebetween a relatively thin working space 27*a* having at its interior boundary an inlet zone 27 and at its exterior boundary a discharge zone 27*b* communicating with channel 22. The material to be treated is continuously fed to inlet zone 27 by any suitable feeding means as a pump, feed screw, or the like (not shown).

In order to provide a limit to the thinness of the working space a shoulder 28 in the hydraulic cylinder 18 limits the upward vertical motion of the piston 17. For many applications the minimum thickness of the working space ranges between a few one-thousandths of an inch to ⅜ of an inch. A stop 29 is also provided in the cylinder head 19 to limit the downward motion of the piston to a point within the suitable operating range of the bearing 6. Usually about one inch is provided for vertical motion of the piston, and consequently of the gyrating plate.

The working pressure of the apparatus, that is, the mutual compressive force exerted by the working surfaces on the material passing therebetween, may be readily controlled by the application of suitable hydraulic or pneumatic pressure at pipe connections 30 and 31. It will be apparent that this also represents a control of the clearance between the working surfaces. Operating conditions of constant clearance or constant pressure may readily be obtained. The often desirable cyclical variation in pressure and clearance may be achieved by the application of hydraulic or pneumatic pressure alternately to pipe connections 30 and 31 or a varying pressure may be applied to cause the gyrating plate to oscillate vertically in any desired type of cycle and any practical frequency. What we achieve by this means is a cyclical increase and decrease of the clearance between the working plates while they are operating under a working pressure of considerable magnitude.

It may be noted that vertical oscillation might be applied to the stationary element rather than to the gyrating element without departing from our invention. It is usually preferable, however, to apply the oscillations to the gyrating element, since the horizontal movement of its journaled bearings renders it more responsive in vertical movement to any selected variation in applied pressure. This is particularly true in applications using a heavy gyrating force, requiring very secure holding means for the non-gyrating element and therefore rendering it difficult to achieve the necessary sensitivity of vertical movement of this element in response to variation of applied pressure.

Figure 2 illustrates a type of working surface and the connections employed when it is desired to add liquid or gases to, or to withdraw them from, the material traversing the working space

between the working surfaces. For the purpose of clarity we have illustrated the working plates separated a distance considerably greater than employed in the operation of the apparatus. 32 is a stationary element which may be substituted for element 21 of Fig. 1. The stationary working surface 33 is illustrated as being roughened in a manner desirable in the processing of paper-making pulp. Each of the annular cavities 34, 35, 36, and 37 communicates to its respective duct or pipe connection 38, 39, 40 and 41. The stationary working surface 33 is perforated over part or all of its area, as at 42, in addition to being roughened to grip the pulp or other material. The plate 43 may be fastened to as a part of the gyrating element 9 and carries the gyrating working surface 43a which is perforated over part or all of its area. As in the case of the stationary element 32, the plate 43 is provided with annular cavities, such as 44 and 45, each of which communicates to a hose connection or duct 46 and 47 which by virtue of its flexibility permits introduction or withdrawal of liquids or gases to or from its respective cavities while the plate 43 is gyrating.

We have shown in Fig. 2 four points of introduction or withdrawal of fluids in the stationary plate and six points for the same purpose in the gyrating plate. In many cases fewer such points are required and in some cases more. Other numbers and arrangements of cavities and points of inlet and outlet may obviously be used.

The perforations may be holes or slots, or may be provided by other foraminous structures such as woven wire screens or by materials of porous structure which will permit passage of fluids from the annular cavities to the working space where it is directly introduced into the material being processed between the surfaces. Thus, by the term perforated plates as used in the disclosure and claims we mean plates having through them multiple passages of the general types described.

It will be apparent that one of the necessary provisions in any given application of the apparatus of our invention is a character of working surfaces which will present a high degree of traction or resistance to slipping on the material being treated between the plates so that the working surfaces can thus transmit the working force into the layer of material from its opposite sides and from opposed and rapidly changing tangential or lateral directions. It is also desirable that the working clearance between the plates be small enough so that the spheres of action produced in the layer of material by each surface meet or overlap in the middle of the layer. On the other hand, the character of the surface in a particular application should be such that it will not unduly retain and build up accumulations of the material under treatment.

Obviously these several practical requirements for the working surfaces may be different for different materials and applications, and we do not limit the scope of our invention to any particular pattern or texture of working surfaces. It is not difficult, however, for one skilled in the art to select a suitable type of surface for the treatment of a given material in a manner and to a degree which may be desired. For treating fibrous pulp a relatively definite, coarse pattern is usually desirable, while for treating a variety of finer materials a relatively fine pattern, in some cases hardly more than a fine grain, may be preferable. For some applications treating viscous liquids, such as the blending of pigments and oils for paints and printing inks, the working surfaces may even be smooth, depending in this case on the adhesion and viscosity of the oil for transmitting the applied working force in the layer or film under treatment.

It is to be noted further that the pattern or texture may not necessarily be the same throughout a given working surface. Thus in some cases the pattern may grade from coarse to fine across the working space to better accommodate the surface to a changing character of the material as it traverses through the working space. Or, a surface may be varied in a way to perform somewhat specialized functions as desired at selected zones in the path of traverse.

In some cases, for example, in processing fibrous material, it is advantageous to provide perforations in certain selected zones of the working surfaces through which a fluid agent may be added to or withdrawn from the material during treatment. The fluid, for example, might be a chemical reagent for carrying out a desired reaction, or a fluid ingredient which it is desired to blend with the material, or it might be water or other liquid for checking the course of a reaction being carried out in the material under treatment, or water for displacement washing of the material under compression between the working surfaces, in which case the wash water would enter at one zone and exit at another zone.

The relative tangential motion of a gyratory character which is provided for the working surfaces as an essential feature of our invention is the same as that specified in our application of even date herewith and it may take various forms as described therein. A preferred embodiment is that in which one of the surfaces is caused to move tangentially relative to the opposed surface in a manner such that all points on the first indicated surface describe circular paths of equal diameter, this diameter being usually only a fraction of the straight-line distance across the working surfaces from the entry to the exit zone.

For different applications of our invention various amplitudes and frequencies of gyration may be used without departing from the spirit of our invention. Amplitudes of a small fraction of an inch to several inches cover the range usually required. In the same way, the range of frequencies may be 50 to 2000 cycles per minute. The amplitude and frequency are related in practical operation since they combine to determine the relative tangential velocity, which as noted should be within the bounds where tractive contact can be maintained between the working surfaces and the material being treated, the nature of the surfaces, the character of the material, and the working pressure being the other important factors in maintaining the necessary tractive contact.

Another essential feature of our present invention is the adaptation of a part or zone of the clearance between the opposed working surfaces to serve as an entry to the working space between the plates through which the material to be treated may be fed by suitable continuous means, and the adaptation of another part or zone or the clearance to serve as an exit for the treated material, the exit zone being so positioned relative to the entry zone that the material in its pass from one to the other traverses a substantial area of working space between the

working surfaces. Thus the feed may be through a central opening in one of two matched circular plates and the exit zone at the periphery, or vice versa, so that in either case the material must traverse the working space for a distance at least equal that from the central opening to the outer edge. Another example is the case of matched rectangular plates of which one edge zone of the clearance is adapted as an entry for the material and an opposite zone adapted as an exit. The entry zone in any case is connected to any convenient continuous feeding means, such as a pump or screw conveyor, and the exit zone similarly integrated with any convenient means for carrying away the treated material.

In our present invention the provision of means for maintaining and controlling a clearance between the opposed working surfaces is generally the same as specified in our application of even date herewith. We do not mean to imply that the clearance of the working surfaces in operation is necessarily fixed and constant, although it may be so fixed in certain applications. The clearance may also be allowed to vary within a controlled and predetermined range to thus accomodate itself to the amount of material forced between the plates, one of which is weighted or otherwise actuated to apply a desired degree of pressure to the layer of material under treatment. Neither do we intend to imply that the clearance is necessarily uniform throughout the working area of a given pair of surfaces. It is in fact usually preferable to provide somewhat greater clearance at the feed zone than near the exit zone. Other variations may also be used for particular purposes. In all cases however an appreciable proportion of the opposed working surfaces are substantially parallel, although not necessarily exactly parallel.

For certain applications it has been found that greatly added efficiency and control may be obtained by providing means to produce a regular cyclical variation in the working clearance between the surfaces, which is in addition to their relative tangential motion of a gyratory character. This provision is generally similar to that specified in our application of even date herewith. The transverse pulsations induced in the layer of processed material by the periodic variation in working clearance still further intensifies the drastic internal agitation produced by the tangential gyratory motion of the surfaces. A particular advantage of the provision for cyclical variation in working clearance is that it may serve as an important aid to and control of the passage of the material through the working space, since by control of the amplitude, period and form of the variation, the rate of passage of the material between the plates may be rendered more responsive or less responsive, as desired, to the feeding pressure. The amplitude of cyclical variation of clearance suitable for many applications of our invention is small, usually under one-quarter of an inch, sometimes as little as a few one-thousandths of an inch. Frequencies of the cycle of clearance variation may cover a wide range for different applications, for example from 5 to several hundred cycles per minute. Various forms of the time-displacement relationship in the individual cycles may be used for different applications, without departing from the spirit of our invention.

In addition to the great effectiveness of the apparatus of our present invention for producing intense agitation and mixing of two or more substances, it may also serve to advantage for agitating a single substance to produce changes in its properties resulting from the unusual type of action. The apparatus may also be adapted to produce a powerful disintegrating action on friable or fibrous materials, and it will be apparent that in such applications it may be necessary to provide for a preliminary, partial subdivision of the material to permit its continuous feed to the entry zone of the working surfaces. It will be apparent also that such disintegration use of our invention may be performed in the presence of softening chemicals, solvents, or other specific agents.

While in the drawing illustrating a preferred embodiment of our invention, we have shown a single pair of working elements, it will be obvious that stacked multiple pairs might be used without departing from the spirit of our invention. Similarly, three elements could be used, the central one serving to provide working surfaces opposed to those of the outside elements, giving in this case therefore two pairs of opposed working surfaces from three working elements, the central one being common to the other two. Such stacking of multiple working elements has some operating advantages such as increased capacity per machine unit, and in the case of cyclical variation in clearance as described, a more even consumption of power.

In other respects also it will be understood that the invention of the present application is not limited to the precise forms of apparatus described herein as constituting embodiments of the invention, and that changes may be made therein without departing from the scope of the invention as defined in the appended claims.

Having thus described our invention, what we claim as new and desire to secure by Letters Patent is:

1. In a machine of the character described, a frame, a pair of working plates mounted on the frame which have opposed working surfaces and which are arranged to form therebetween a thin working space, said working surfaces being roughened for tractive contact only with the material in the working space at top and bottom, respectively, of said material, means for pressing one of the plates toward the other to apply a load to the material between them, means for imparting an eccentric gyratory motion to one of the plates about an axis extending in the direction of compression, means for constraining said motion so that all points in the moving working surface trace separate, identical paths relative to the other working surface, one of said plates, at least, being perforated, and ducts for conducting liquid to said perforations.

2. In a machine of the character described, a frame, a pair of working plates mounted on the frame which have opposed working surfaces and which are arranged to form therebetween a thin working space, said working surfaces being roughened for tractive contact only with the material in the working space at top and bottom, respectively, of said material, means for pressing one of the plates toward the other to apply a load to the material between them, means for imparting an eccentric gyratory motion to one of the plates about an axis extending in the direction of compression, a plurality of rods equi-spaced angularly around the axis of the gyratory plate, each of said rods being connected at one end by a universal joint to the gyratory plate and at its opposite end by a universal joint to the frame,

one of said plates, at least, being perforated, and ducts for conducting liquid connected to said perforations.

3. A machine for processing paper-making pulp comprising two plates having opposed working surfaces arranged to form therebetween a relatively thin working space, means pressing one of the plates toward the other to compress pulp between their working surfaces, means for effecting relative gyratory motion between the plates about an axis extending in the direction of compression, said working surfaces being basically smooth surfaces but having tiny, spaced protuberances thereon which project into the working space to provide traction for the pulp without obstructing rolling traverse of the pulp on the surfaces in said gyratory motion, one, at least, of said plates being perforated for introduction of a liquid into or withdrawal of a liquid from the working space, and liquid-conducting ducts connected to said perforations.

4. A machine for processing paper-making pulp comprising two plates having opposed working surfaces arranged to form therebetween a relatively thin working space, means pressing one of the plates toward the other to compress pulp between their working surfaces, means for imparting a gyratory motion to one of the plates about an axis extending in the direction of compression, means connected to said one plate and constraining the same so that all points in said one plate trace separate, identical closed paths during the gyratory motion of said one plate, said working surfaces being basically smooth surfaces but having tiny spaced protuberances thereon which project into the working space to provide traction for the pulp without obstructing rolling traverse of the pulp on the working surfaces in said gyratory motion, both of the plates being perforated, ducts connected to one of the plates and its perforations for supplying a liquid to the working space, and ducts connected to the other plate and its perforations for withdrawing liquid from the working space.

5. A machine for processing paper-making pulp comprising two plates having opposed working surfaces arranged to form therebetween a relatively thin working space, means pressing one of the surfaces toward the other to compress pulp between them, an inlet for pulp at one boundary of the working space, a discharge outlet for the pulp at another boundary of the working space, means pressing one of the plates toward the other to compress pulp between their working surfaces, means for effecting relative gyratory motion between the plates about an axis extending in the direction of compression, said working surfaces being basically smooth surfaces but having tiny, spaced protuberances thereon which project into the working space to provide traction for the pulp without obstructing rolling traverse of the pulp on the surfaces from the inlet to the outlet during said gyratory motion, one of said plates, at least, being perforated, the perforations of said one plate being arranged in zones between the inlet and the outlet, and separate liquid-conducting ducts connected to the perforations of the different zones so that liquids may be introduced into or withdrawn from the pulp in different zones of its rolling traverse on the working surfaces from the inlet to the outlet.

6. A machine for processing paper-making pulp comprising two plates having opposed working surfaces arranged to form therebetween a relatively thin working space, means pressing one of the surfaces toward the other to compress pulp between them, an inlet for pulp at one boundary of the working space, a discharge outlet for the pulp at another boundary of the working space, means pressing one of the plates toward the other to compress pulp between their working surfaces, means for imparting a gyratory motion to one of the plates about an axis extending in the direction of compression, means connected to said one plate and constraining the same so that all points in said one plate trace separate, identical closed paths, said surfaces being basically smooth surfaces, but having tiny, spaced protuberances thereon which project into the working space to provide traction for the pulp without obstructing rolling traverse of the pulp on the surfaces from the inlet to the outlet during said gyratory motion, both of the plates being perforated, and each having its perforations arranged in zones between the inlet and the outlet, and separate liquid-conducting ducts connected to the perforations of the different zones so that liquids may be introduced into or withdrawn from the pulp in different zones of its rolling traverse on the working surfaces from the inlet to the outlet.

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