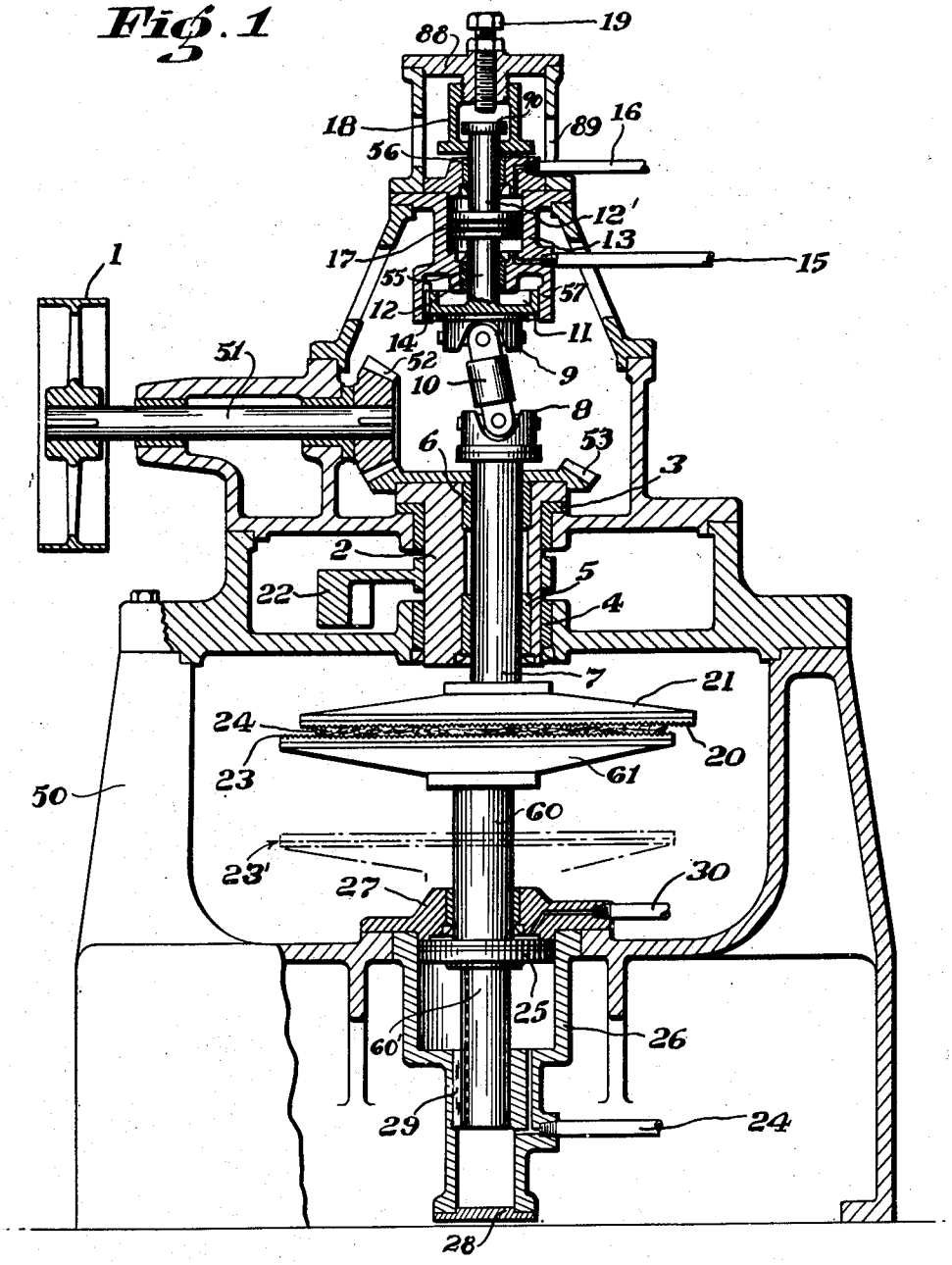
July 28, 1953 J. T. COGHILL ET AL 2,646,728

APPARATUS FOR TREATING WOOD PULP

Filed Oct. 25, 1946 4 Sheets-Sheet 1

Fig. 1



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Fig. 2

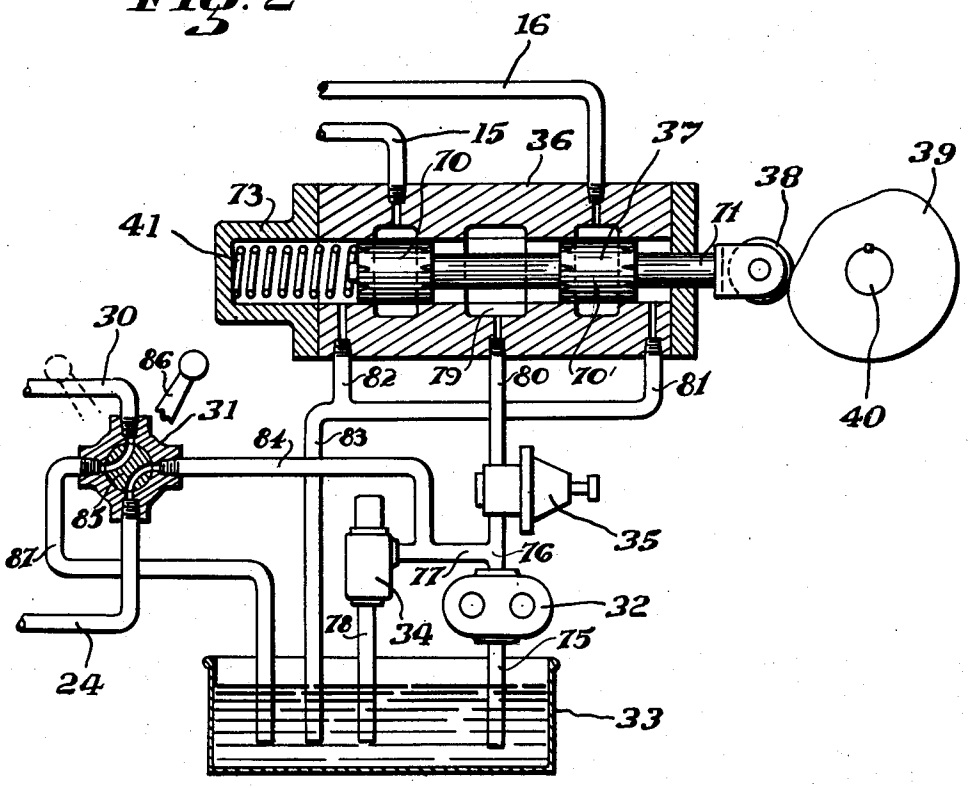
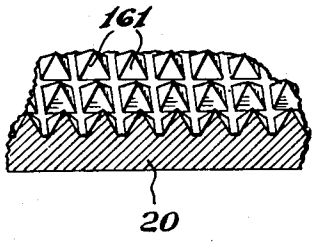


Fig. 4



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APPARATUS FOR TREATING WOOD PULP

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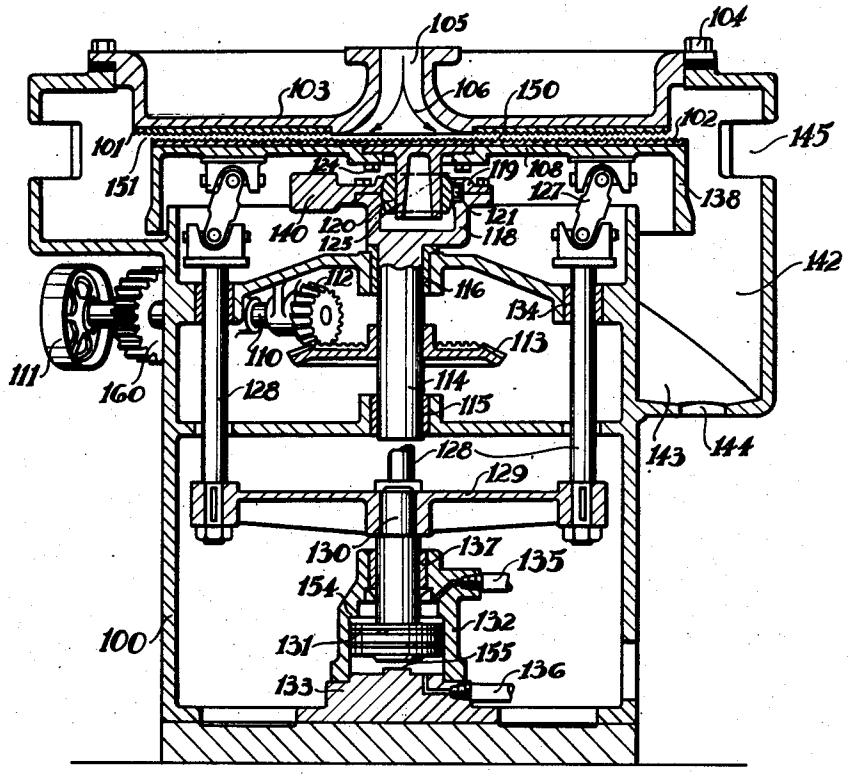


Fig. 3

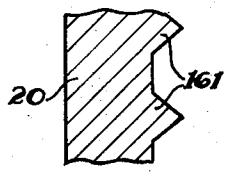


Fig. 6

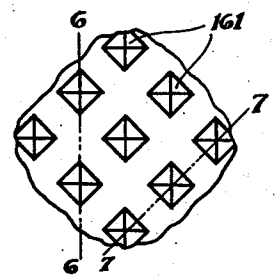


Fig. 5

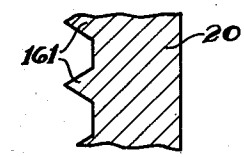


Fig. 7

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APPARATUS FOR TREATING WOOD PULP

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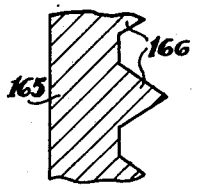


Fig. 9

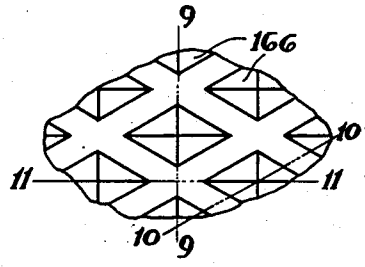


Fig. 8

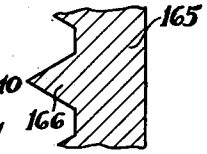


Fig. 10

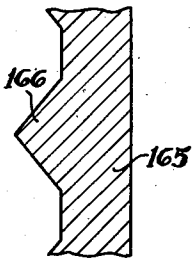


Fig. 11

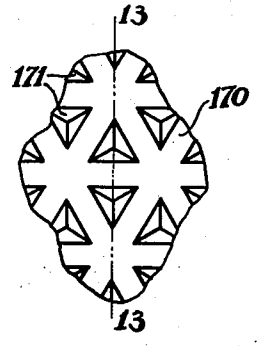


Fig. 12

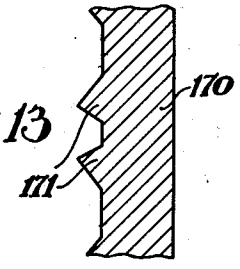


Fig. 13

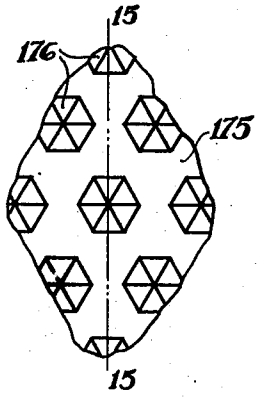


Fig. 14

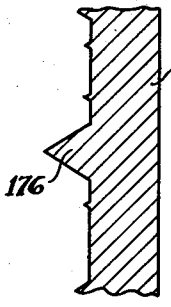


Fig. 15

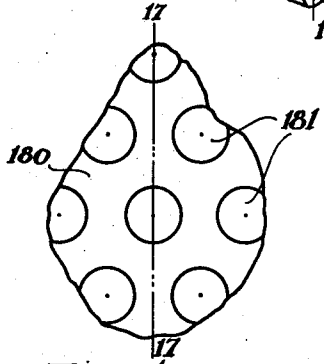


Fig. 16

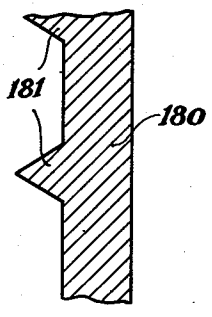


Fig. 17

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Patented July 28, 1953 2,646,728

UNITED STATES PATENT OFFICE

2,646,728

APPARATUS FOR TREATING WOOD PULP

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Application October 25, 1946, Serial No. 705,540

8 Claims. (Cl. 92—26)

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The present invention relates to machines for processing fibrous material and particularly wood pulp for making paper. In a more specific aspect, the invention relates to machines for mechanically processing wood pulp according to the method disclosed in the Hill and Edwards application Serial No. 565,128, filed November 28, 1944, now Patent No. 2,516,384, granted July 25, 1950. There is specifically illustrated and described in that application one type of organized machine for practicing the process disclosed therein. The present invention relates to machines of another type for practicing that process. This application is a continuation in part of our application Serial No. 674,671, filed June 6, 1946, which has been abandoned, and is a continuation in part, also, of our application Serial No. 674,672, filed June 6, 1946, now Patent No. 2,599,543, granted June 10, 1952.

The process of Patent No. 2,516,384 produces results in the processing of pulp which are of revolutionary character. For production of some types of paper-making pulp it may be used as a preliminary to the basic step of refining the pulp which may be done by a conventional refining method. For production of other types of paper-making pulp, the process of Patent No. 2,516,384 may be used in reality as the basic method of treatment, although for obtaining particular desired qualities in the paper to be produced the pulp may subsequently be subjected for a short period to treatment in a beater or jordan or other conventional refiner. For production of still other types of paper-making pulp, the method of Patent No. 2,516,384 may be used in lieu of conventional refining methods, and these methods eliminated entirely. In comparison to conventional refining methods, the process of Patent No. 2,516,384 makes possible entirely new combinations of pulp properties which greatly extend the usefulness and value of wood pulp in the great number of products to which it can be converted. In addition, the marked improvement in appearance and cleanliness of the pulp which are characteristic effects of the new process permit substantial economies by making it possible to eliminate equipment and processing steps hitherto required to maintain accepted standards of quality; and they permit improved yields of pulp from the wood without sacrifice of quality.

In the process of Patent No. 2,516,384, the pulp, which is to be treated, is rolled traversingly in tractive contact with and under compression by two opposed working surfaces. The pulp may be

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previously nodulated, but, if not, it will be formed, as it rolls between and over the working surfaces under compression, into nodules in which the fibres of the pulp are intertwined and curled on one another. As the nodulated pulp is rolled traversingly under compression between and over the working surfaces, the nodules of the plup will be formed into rotatable units and these units will be caused to travel rollwise under compression, thereby causing continuous reorientation of the nodules relative to the direction of applied pressure. Thus, the pulp fibres or fibre bundles will be bent, and twisted and subjected to increased contortion as the units of nodules roll traversingly over the working surfaces. This causes separation or liberation of the fibres which may be bonded together without mutilating the fibre structure or forming fibre debris. Thus, the method of Patent No. 2,516,384 provides an effective means of eliminating the small but undesirable shive content of regular commercial grades of pulp, such as sulphite, kraft, and soda pulp. Moreover, it supplies a new step in the production of so-called high-yield or semi-chemical pulps, all of which must pass through an intermediate stage, if a large percentage of shives or fibre bundles are present, in order to reduce the individual fibres to the extent required to form a clean sheet of paper. The method of Patent No. 2,516,384 unbonds or liberates the individual fibres to an essentially complete degree with a very low expenditure of power and without sacrifice of freeness.

The present invention has for one object the provision of a simple and compact but fast, thorough and efficient machine for carrying out the process of Patent No. 2,516,384.

Another object of the invention is to provide a machine which will permit performance of the process of Patent No. 2,516,384 in a continuous operation.

Still another object of the invention is to provide suitable working surfaces for machines for effecting the process of Patent No. 2,516,384.

Other objects of the invention will be apparent hereinafter from the specification and from the recital of the appended claims.

In the drawings:

Fig. 1 is a vertical sectional view of a machine constructed according to one embodiment of the present invention;

Fig. 2 is a somewhat diagrammatic view showing the hydraulic circuit, which may be employed in the machine of Fig. 1, for providing and controlling the working pressure;

Fig. 3 is a vertical sectional view of a machine constructed according to a different embodiment of the invention;

Fig. 4 is a perspective view on an enlarged scale, showing fragmentarily one form of working surface that may be employed with a machine constructed according to this invention;

Fig. 5 is a fragmentary plan view on an enlarged scale of the working surface shown in Fig. 4;

Fig. 6 is a section on the line 6—6 of Fig. 5;

Fig. 7 is a section on the line 7—7 of Fig. 5;

Fig. 8 is a fragmentary plan view on an enlarged scale, showing another form of working surface;

Fig. 9 is a section on the line 9—9 of Fig. 8;

Fig. 10 is a section on the line 10—10 of Fig. 8;

Fig. 11 is a section on the line 11—11 of Fig. 8;

Fig. 12 is a fragmentary plan view of still another form of working surface;

Fig. 13 is a section on the line 13—13 of Fig. 12;

Fig. 14 is a fragmentary plan view of a working surface made according to a further modification of the invention;

Fig. 15 is a section on the line 15—15 of Fig. 14;

Fig. 16 is a fragmentary plan view of a working surface made according to a still further modification of the invention; and

Fig. 17 is a section on the line 17—17 of Fig. 16.

In a machine built according to the present invention, the pulp to be treated is rolled in different directions traversingly between two opposed working surfaces while under compression by and in tractive contact with the working surfaces. In preferred embodiments of the invention, the rolling motion is effected by imparting a gyratory or orbital motion to one of the working surfaces about an axis approximately perpendicular to that surface, and the other surface is maintained relatively fixed during the rolling operation. Preferably, the machine is provided with approximately parallel working surfaces.

There are two modifications of the invention shown in the accompanying drawings. In one, the machine is of the intermittent type; and in this machine the surface, which is relatively fixed during operation, is movable away from the gyrating surface to permit treated pulp to be removed from the machine and untreated pulp to be loaded into the machine for treatment. In the other modification of the invention, the pulp is fed continuously into and between the working surfaces through an inlet opening provided centrally of the stationary surface, and after treatment the pulp is discharged at an outlet zone around the periphery of the gyrating surface. In both machines, provision may be made for imparting a cyclical motion to the gyrating surface to move it in the direction of its orbital axis toward and from the other surface during operation. In both machines, this cyclical motion of one working surface toward and away from the other assists in treating the pulp, while in the continuous type machine the cyclical increase in clearance between the working surfaces permits of freer movement, also, of the pulp from feed opening to discharge point.

The gyratory or orbital motion of the working surfaces relative to one another causes the pulp between the surfaces to be formed into small discrete nodules in which the fibres are curled and intertwined; and it causes these nodules to be formed into rotatable units composed of one or more nodules and to be rolled traversingly over the surfaces. As the nodules roll, moreover, the compression under which they roll causes the fibres to be bent continuously in changing orientation to the direction of compression, increasing the contortion or bending and curling of the fibres. Furthermore, the nodules are continuously regrouped and reformed into new rotatable units. All this continuously changes the direction of application of pressure to the fibres, and they are continuously bent or curled and rebent and recurled, further increasing their contortion. Thus, the properties of the pulp are modified and the results are attained which are sought in the process of Patent No. 2,516,384.

For efficient operation of machines constructed according to the invention, the working surfaces must be knurled, figured or otherwise roughened so as to grip the pulp and resist slippage of the working surfaces on the surface of the pulp pressed against them as the gyrating surface partakes of its gyratory or orbital movement. The working surfaces must have a maximum degree of tractive contact with the pulp, for it is this tractive contact plus the relative gyratory motion of the opposed surfaces, plus the compression exerted on the pulp by the surfaces which causes the pulp in the form of small units to traverse rollwise relative to the sufaces, enabling the unique and desirable actions and effects on the individual fibres of the pulp, which are the purpose of the process disclosed in Patent No. 2,516,384, to be attained.

It will be apparent that a proper working surface for this purpose must not have a type of roughness which will entangle and retain pulp fibres, nor can it have projections or configurations of such size, shape, or spacing as to interfere with the intended rollwise traverse of small pulp units over the surface. In short, what is required is a surface which will promote rollwise traverse of the pulp units under the conditions of operation. This means a surface which provides the necessary traction while at the same time presenting a suitable contour to permit traverse. The range of surface textures and configurations, which may be used, will depend upon the type of pulp and the operating conditions of a particular use. Thus, a long fibred pulp, such as kraft, wil permit the use of a generally coarser surface pattern than will a short fibred pulp, such as groundwood. Several different forms of satisfactory working surfaces have been illustrated in the accompanying drawings and will be described in further detail hereinafter.

Referring now to the drawings by numerals of reference, and first particularly to the embodiment of the invention illustrated in Figs. 1 and 2, 1 denotes the drive pulley of the machine. This pulley is keyed to a shaft 51 which is suitably journaled in the frame 50 of the machine. Keyed to the inner end of the shaft 51 is a bevel pinion 52 which meshes with and drives a bevel gear 53. The bevel gear 53 is secured in any suitable manner to a cylindrical barrel 2 which is journaled on suitable bearings or bushings 3 and 4 in the frame of the machine. The barrel 2 is provided with an eccentric bore which is fitted with bearings or bushings 5 and 6 to receive the reciprocating rod or plunger 7. The bushings 5 and 6 permit rotation of the barrel 2 on the plunger 7 and reciprocation of the plunger 7 in the barrel 2 during rotation of the barrel. The plunger 7 is connected by means of a pair of

universal joints 8 and 9 and a link 10 to the flanged head 11 of the piston rod 12 which projects from one side of a piston 17.

The piston 17 is reciprocable in a cylinder 13 which is secured to an upright portion of frame 50. The piston has a piston rod 12' projecting from its opposite side. The ends of the cylinder are closed by suitable packing glands 55 and 56 which provide, also, suitable guide bearings for the piston rods 12 and 12'. The rim of the flanged head 11 is connected by a key 14 with an extension 57 of the cylinder 13 so that the head 11 is prevented from rotating as the piston 17 moves vertically in the cylinder. The piston is adapted to be reciprocated by hydraulic pressure which may be applied selectively to opposite faces of the piston through the pipes 15 and 16.

When the barrel 2 is rotated, the plunger 7 is caused to travel, relative to the bearings 3 and 4, in a circular path having a radius equal to the eccentricity of the bearings 5 and 6. The bore of the cylinder 13 is coaxial with the bearings 3 and 4. During the gyratory or orbital movement of the plunger 7, the plunger is prevented from rotating on its own axis relative to the frame of the machine by reason of its connection through the universal joints 8 and 9 to flange 11, which, as already stated, is held against rotation by key 14.

Fastened to the lower end of the plunger 7 is a head 21 to which is secured the upper working surface 20 of the machine. This surface is preferably circular, although it may be of any other desired shape.

Mounted to reciprocate in a cylinder 26, which is provided in the base of the machine, is a piston 25. The upper end of the cylinder 26 is closed by the head 27, and its lower end by the head 28. Integral with the piston 25 and projecting upwardly from one face thereof is a piston rod 60, and fastened to the upper end of this piston rod 60 is a head 61. To the upper face of this head is secured the lower working surface 23 of the machine which is also preferably circular in shape. Integral with and projecting from the lower face of the piston 25 is the piston rod 60'. The piston 25 is adapted to be reciprocated by application of fluid pressure selectively to its opposite faces through the pipes 24 and 30.

During the operation of the machine, while the pulp is being treated the lower working surface 23 is held in fixed vertical position by application of hydraulic pressure to the lower side of piston 25 through pipe 24. This pressure forces the piston 25 upwardly in the cylinder 26 and tightly against the cylinder head 27. When the treatment of the pulp has been completed, and it is desired to introduce a new charge of untreated pulp into the machine, the pipe 24 is put on exhaust and the pipe 30 on supply. This causes the lower working surface to be withdrawn to a position as indicated in dotted lines at 23' so that the new supply of pulp to be treated can readily be placed on the lower working surface. The key 29 which connects the piston rod 60' to the cylinder 26 prevents rotation of the piston 25.

The movements of the pistons 17 and 25 may be controlled in any suitable manner. One form, which the control mechanism may take, is illustrated in Fig. 2. As shown, the pipes 15 and 16 are connected to the casing 36 of a well-known type of four-way valve 37. The collar or operating portions 70 and 70' of this valve are

notched to provide for graduated oil flow. Mounted upon the stem portion 71 of this valve, which projects through one end of the valve casing, is a roller 38 which engages against the periphery of a cam 39. The cam 39 is keyed to a shaft 40 which is adapted to be driven from a suitable source of power (not shown) but which may be driven, for instance, in time with the rotation of the barrel 2 through gearing (not shown) operatively connected to the shaft 51. The spring 41, which is interposed between one end of the valve 37 and the end-plate 73 of the valve casing, holds the roller 38 continuously in operative engagement with the cam 39.

33 denotes a sump or reservoir provided in the base of the machine, and 32 denotes a standard pump for drawing the hydraulic motive fluid from this reservoir. The pump sucks the oil out of the reservoir through a pipe 75 and delivers it through a pipe 76 to a pressure regulating valve 35. 34 designates a relief valve which is connected with pipe 76 by pipe 77. The relief valve by-passes excess fluid to the sump 33 through the pipe 78. The pressure regulating valve 35 is connected with the central chamber 79 of the valve casing 36 by a pipe 80. Pipes 81 and 82 connect opposite ends of the valve casing with an exhaust pipe 83 which returns to the sump. A pipe 84 connects the pipe 77 with a standard manually operable two-way valve 85. This valve is mounted in a casing 31 and is operable by the hand lever 86. It is connected by the pipe 87 with the sump 33 and is connected by the pipes 24 and 30, respectively, with opposite ends, respectively, of the cylinder 26.

By rotation of the valve 85, it will be seen that the lower working surface 23 may be raised or lowered. As the cam 39 rotates, the hydraulic pressure from the regulator 35 is applied alternately to the upper and the lower surfaces of the piston 17. Thus, this piston and the upper working surface 20, which is connected thereto, may be caused to move up and down on a regular cycle, the frequency of which is determined by the speed of rotation of the cam 39. The relative length of the periods of upward and downward pressures and the rapidity of the transitions therebetween are determined by the shape of the particular cam 39 used.

The working clearance between the upper and lower working surfaces is determined by adjustment of a stop member 18 (Fig. 1) and a stop screw 19. The screw 19 threads into the end-plate 88 which closes the upper end of the column of the machine, and this screw is adapted to engage the upper end face of the piston rod 12'. The stop member 18 threads onto a central boss provided on the end-plate 88 and is adapted to engage the shoulder or collar 90 formed on the piston rod 12'. Openings 89 in the frame permit of access to the stop member 18 to allow of adjustment of the same.

From the foregoing description, it will be apparent that by adjusting the stops 18 and 19 relative to each other the vertical position of the upper working surface 20 may be fixed at any desired working clearance with respect to lower working surface 23. Also, stop 18 may be adjusted so as to provide a minimum amount of clearance, and stop 19 adjusted for a maximum amount of clearance. Thus, by means of a proper cam 39 rotating at a suitable speed the work-ink clearance may be caused to vary between specific limits with a regular cycle of any desired frequency and amplitude. On the other

hand, by withdrawing the stops 18 and 19 and stopping the rotation of the cam 39 in such a position that the regulated hydraulic pressure is continuously applied to pipe 16, the layer of pulp being treated may be subjected to any desired total compressive force, and the upper working surface will float vertically at whatever clearance the pulp layer under treatment may determine. Also, with stops 18 and 19 withdrawn and with the cam 39 rotating, the compressive force on the pulp layer may be caused to pulsate in any desired manner for purposes to be described hereinafter.

In using the machine shown in Fig. 1, the lower working surface 23 is first lowered to open position shown at 23' and a charge of pulp, for instance, sulphite pulp of 15% consistency, is placed centrally on said lower working surface, the charge being equal to about 0.1 pound per square inch of effective working surface. Power is then applied to pulley 1 to rotate barrel 2, causing a gyratory or orbital motion to be imparted to upper working surface 20. The parts are preferably constructed so that the orbital motion imparted to the upper working surface 20 may be of an amplitude of the order of ¾ of an inch diameter with a gyration frequency of, for example, 1100 cycles per minute. The lower working surface is then elevated to its fixed working position so as to compress the charge of pulp between the working surfaces with a pressure of about 5 pounds per square inch of surface area in engagement with the pulp. The pressure may be obtained by a suitable hydraulic pressure applied to piston 17. Alternatively, the desired compression of the pulp may be obtained by elevating the lower working surface to its fixed working position with the upper working surface locked in a suitable vertical position by means of the stops 18 and 19. The gyrating action on the pulp under compression is continued for a suitable length of time, as little as two seconds having been found sufficient in practice for some grades of pulp. Then the lower working surface is lowered to open position 23' and the charge of treated pulp removed from the apparatus.

The above described action leaves the pulp in a highly nodulated state, which however may readily be converted to the dispersed fibre suspension state usual in paper-making processes by suitable mixing and agitation with water. As a result of its treatment in our machine the pulp will be found to have undergone the series of unique and distinctive property changes set forth in application Serial No. 565,128, now Patent No. 2,516,384, as typical of the method described therein, including the defibering of shives which may have been present in the pulp charge and the virtually complete dispersal of visible dirt.

It will be apparent that instead of batch-charge operation as described, the machine described may be adapted to semi-continuous operation by properly synchronizing movements through devices readily available. Thus, with the upper working surface gyrating continuously, the required vertical movements of the lower working surface may be obtained by means of a cam mechanism. While the lower working surface is in the lowered or open position, the treated pulp may be removed by properly synchronized action of a scraper device or an air-jet, following which the new charge of pulp may automatically be spread on the lower working surface prior to its return to the raised or operating position. These operations repeated continuously in sequence would thus represent a semi-continuous application of the apparatus of our invention which would serve to treat a flow of pulp in a mill process.

Fig. 3 shows a modification of the invention which is adapted to fully continuous operation. Here, 100 denotes the base or frame of the machine which is generally circular. The upper and lower working surfaces, which are again preferably made circular in shape, are denoted at 101 and 102, respectively. The upper working surface 101 is stationary and is secured to a cylindrical support 103 which is fastened by screws 104 to the upper surface of the base or frame 100. The support 103 is formed with a central inlet opening 105 through which pulp may be fed between the working surfaces, as denoted by arrows 106.

The lower working surface 102 is secured to a cylindrical supporting member 108 to which is imparted a gyratory or orbital motion. This motion is produced by rotation of the shaft 110 which is driven by a pulley 111 that is secured to the shaft. The shaft 110 is suitably journaled in the base 100 of the machine and secured to its inner end is a bevel pinion 112. This pinion meshes with a bevel gear 113 which is keyed or otherwise fastened to a shaft 114. The shaft 114 is suitably journaled on bushings 115 and 116 in the frame 100. At its upper end, the shaft 114 terminates in a circular cup 118 which is eccentric of the axis of rotation of the shaft. Secured to the cup member 118 is a cap member 119. The cup member 118 has a part of its bore formed to a concave spherical shape, and the cap member 119 is also formed internally with a concave spherical surface matching the spherical surface of the member 118. Mounted in the spherical surfaces of the members 118 and 119 is a journal bearing 120 having a convex spherical surface that seats in the concave spherical surfaces of said members. This bearing has a lug or protrusion 121 which engages in a recess in the cap member 119 to prevent rotation of the bearing relative to cap member 119 and cup member 118. The lug 121 permits, however, of moderate self-aligning motion of bearing 120. Secured to the supporting member 108 by means of screws 124 is a crank-pin 125 which is mounted within the journal bearing 120. As the shaft 110 rotates, then, it will be seen that the crank-pin 125 is driven in a circular path having a radius equal to the eccentricity of the cup 118.

The crank-pin 125 is made somewhat longer than the bushing 120 so that it can move vertically up and down in the bushing while the bushing still has a driving connection therewith. This permits of movement of the lower working surface 102 toward and away from the upper working surface 101 while still effecting orbital motion of surface 102.

The support 108 is connected by four pairs of universal joints 127 with four connecting rods 128. Two of these universal joints only are shown in Fig. 3, the other two being at 90 degrees apart from the two shown in that figure. The upper end of each pair of universal joints is bolted to the gyrating element 108 while the lower end is bolted to one of the connecting rods 128. These connecting rods are reciprocable in bearings 134 provided in the frame and are rigidly attached at their lower ends to a yoke member 129 which is fastened to the piston rod 130. The piston rod 130 is connected to a piston 131 which operates in the cylinder 132. The lower end of this cylinder is closed by the cylinder head 133 which is

fastened to the base or frame of the machine. Fluid under pressure is admitted selectively to opposite ends of the cylinder 132 through the pipes 135 and 136. These pipes may be connected to a control valve 36 (Fig. 2) suitably positioned on the machine in the same way as are the pipes 15 and 16 (Fig. 1), respectively.

It will be obvious that with each of the connecting rods 128 mounted for free vertical motion in the bearings 134 and with the piston rod 130 mounted for free vertical motion in the bearing 137, 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 127, which are customarily used to transmit rotation through misaligned shafts, are applied in the present machine to prevent rotation of the gyrating element 108 and to control its vertical position as well as to apply pressure for treatment of the pulp.

In the machine described, there are four universal joints used 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.

It will be seen from the structure described above that when the shaft 114 is rotated, the element 108 is caused to gyrate in a circular path having a radius equal to the eccentricity between cup 118 and the axis of shaft 114, but that this element is prevented from rotating on its own axis by the universal joints so that all points on its surface travel in separate circular paths of equal diameter.

In order to prevent excess vibration of the machine, due to the weight of the gyrating parts, the supporting plate 108 is provided with an integral flange or apron 138 which extends downwardly from the rim of the gyrating element to bring the vertical center of gravity of the gyrating parts into a position where the centrifugal force of these parts can be counterbalanced by a counter-weight 140 which is formed as part of the cap member 119. This method of counter-balancing provides complete elimination of vibration for one selected vertical position of the gyrating element and approximate balancing for other vertical positions.

As already stated, the pulp is adapted to be fed continuously through the inlet 105 in the upper plate 102 into the space between the working surfaces. The two working surfaces 101 and 102 form therebetween a relatively thin working space 150 having at its interior boundary an inlet zone 105 and at its exterior boundary a discharge zone 151 communicating with the trough 142. The material to be treated may be continuously fed to the inlet zone 105 by any suitable feeding means as a pump, feed screw, or the like (not shown).

The gyrating movement and the pressure of the pulp being fed into the central inlet, causes the treated material to move traversingly over and between the working surfaces 102 and 103 to the periphery of the surface 102 where it drops into the trough 142. This trough extends around the outside of the base 100 of the machine and is provided with a downwardly inclined spiral bottom 143 that leads to an outlet 144. This outlet may be connected to any suitable receptacle, or to apparatus for conveying the treated pulp on for further processing when the present machine constitutes part of a continuous set-up. 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 single discharge point with a liquid. Observation and access openings are provided around the trough 142 at 145.

In order to provide a limit to the thinness of the working space, a shoulder 154 is formed in the cylinder 132 to limit the upward vertical motion of the piston 131. A stop 155 is also provided in the cylinder head 133 to limit the downward motion of the piston to a point within the suitable operating range of the bearing 120. For many applications, the minimum thickness of the working space ranges between a few thousandths of an inch to three-eighths of an inch. Usually about one inch is provided for vertical motion of the piston and consequently of the gyrating plate 108.

The working pressure of the apparatus, that is, the mutual compressive force exerted by the working surfaces on the material passing therebetween may readily be controlled by the application of suitable hydraulic or pneumatic pressure at the pipe connections 135 and 136. 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. Cyclical variation in pressure and clearance may also be achieved by the application of hydraulic or pneumatic pressure alternately to the pipe connections 135 and 136, or a varying pressure may be applied to cause the gyrating plate 108 to reciprocate vertically in any desired type of cycle and with any practical frequency. For treating pulp in our apparatus we may provide for working pressures having a range of from one to twenty pounds per square inch of effective working surface. For cyclical variation in pressure and clearance, the control mechanism of Fig. 2 may be used on the machine of Fig. 3, and the cam 39 may be driven in time with the shaft 110 through suitable gearing one member of which 160 is secured to rotate with drive shaft 110 and a final member of which (not shown) is secured to cam shaft 40.

It is to be noted that the vertical oscillation might be applied to the stationary element 103 rather than to the gyrating element 108 without departing from our invention. It is usually preferable, however, to apply the oscillations to the gyrating element since the horizontal movement of its journal 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 means for holding 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.

In a machine operating like the machine of Fig. 3 according to a continuous process, it is necessary that the pulp being treated between the opposed working surfaces should move between them from the inlet zone through the treating zone to the outlet zone, and that this movement be in addition to the circular traverse of rotatable units of pulp as induced by the relative gyratory motion of the surfaces. This overall movement of the pulp being treated we call "migration" and, as will be seen, it necessitates

a small degree of slippage of the rotatable units of pulp as they traverse rollwise over the treating surface. Thus, where one treating surface is stationary and the other gyrating in a circular path, the rotatable pulp units under compression follow circular paths if undisturbed by the addition of fresh pulp at the inlet zone. When such fresh pulp is added it immediately becomes nodulated and the pulp already undergoing treatment migrates into the area of least resistance to make room for the fresh pulp.

It will be apparent that one of the necessary provisions in any given application of the apparatus of our invention are working surfaces which will present a high degree of traction or resistance to slippage on the material being treated between the surfaces so that the working surfaces can thus transmit the working force into and throughout the layer of material from its opposite sides and from opposed and rapidly changing tangential or lateral directions.

We have found that the working surfaces are most suitable and most productive when they consist of basically flat or smooth surfaces upon which are superimposed a multiplicity of tiny protrusions in the form of pointed pyramids. Grooves in the treating surface tend to be less productive than points extending thereabove, since they offer cavities in which nodules may become imbedded and thus diminish the tractive properties of the surface. We have found that pointed protrusions extending from an essentially flat surface provide the necessary conditions for rollwise traverse of the pulp nodules or rotatable units thereof. The size of the pointed protrusions for engagement of fibrous pulp may range from .005 inch in height up to .075 inch depending upon the length and other characteristics of the fibre and also upon the degree of compression which is to be employed in treating the fibre for a particular purpose. Higher degrees of compression in general require a larger number of points having less height.

In order to permit rollwise traverse of pulp nodules or rotatable units thereof, we have found that the pointed protrusions should be spaced adjacent to one another a distance of from 1½ to as much as 3 or 4 times their height. If the spacing is too close the cavities between the points may fill up with stagnant pulp and the surfaces will not be self-cleaning which is a necessary condition in obtaining the required rollwise traverse. If the pointed protrusions are spaced too far apart, the gripping of the nodules or rotatable units thereof is diminished and the required rollwise traverse can not be achieved at as high a speed or under as high compression. In other words, in this case the degree of tractive contact is diminished.

We prefer a symmetrical pattern of pyramidal pointed protrusions since such a pattern may be readily machined by means of milling cutters on a metal surface. Several types of patterns which have been found satisfactory in practice, are shown in Figs. 4 to 17 inclusive.

The working surface 20 shown in Figs. 4 to 7 inclusive has a symmetrical pattern of pointed protrusions 161 in the form of closely spaced regular quadrilateral pyramids which project from the basic surface 20. We have found that the included angle formed by the mutually facing sides of adjacent pointed protrusions is important. It may range between 40 and 100 degrees. If the angle is too great the material being treated will tend to slip, while if the angle is too small the material will tend to bind around the protrusions and the rollwise traverse of pulp nodules or rotatable units thereof will be impeded. In the surfaces shown in Figs. 4 to 7 inclusive, the sides of the pyramids are inclined to one another at an angle of approximately 60 degrees in the view of Fig. 7 and at an angle of approximately 80 degrees in the view of Fig. 6. In one form of working surface constructed according to the pattern of Figs. 4 to 7 inclusive, the lands between the bases of adjacent pyramids are .023 inch in a section corresponding to Fig. 7, while the bases of the pyramids measure in this same section .027 inch. The pyramids have a height of .0234 inch.

Figs. 8 to 11 inclusive illustrate another form of working surface with a different type of four-sided pyramidal projections. Here, the base of the working surface is denoted at 165 and the pyramidal protrusions at 166. In the view of Fig. 9, there is an angle of 68 degrees between the sides of the pyramid; in the view of Fig. 10, there is an angle of 60 degrees; and in the view of Fig. 11, there is an angle of 102 degrees. In one embodiment of working surface constructed according to the pattern of these figures, the lands between adjacent pyramids is .018 inch in width in a section corresponding to Fig. 10, while the base of the pyramids is .0445 inch in width. The pyramids have a height of .0385 inch.

Figs. 12 and 13 illustrate a working surface on which the protrusions are three-sided symmetrical pyramids. Such a working surface may be produced by milling a surface similar to that shown in Figs. 8 to 11 inclusive and then cutting diametrically across the pyramids so produced with a V-shaped milling cutter. In the views of Figs. 12 and 13, the base portion of the working surface is denoted at 170 and the pyramidal protrusions at 171. In one form of working surface constructed according to the pattern of these figures, the lands between adjacent pyramids are .018 inch in width and the pyramids are .0411 inch in length on their sides at their bases in a section like Fig. 13. The pyramids have a height of .0205 inch.

Another form of working surface is shown in Figs. 14 and 15. Here an hexagonal pyramidal pattern is employed. The base of the working surface is denoted at 175 and the protrusions at 176. The sides are inclined to one another at an angle of 60 degrees in the view of Fig. 15. In one form of working surface constructed according to the pattern of these figures, the pyramids measure at their base .0445 inch in a section corresponding to Fig. 15. The pyramids have a height of .0385 inch.

Figs. 16 and 17 illustrate a surface pattern in which the protrusions are right circular cones 181 that project above the base portion 180. The dimensions of the protrusions as regards height and width at base may be the same as in the case of the protrusions shown in Figs. 14 and 15. The conical protrusions are more costly to machine than the pyramidal protrusions, but may readily be moulded.

While in the particular embodiments of the invention described the working surfaces are shown parallel, it should be noted that the opposed working surfaces need not be parallel throughout their entire area and may deviate from true parallelism so long as the condition of rolliwse traverse of the working surfaces by the nodulated pulp is met. In the working condition, the pulp is in a nodulated state, and the lay-

er of these nodules or aggregates thereof may be largely continuous, representing close packing of the pulp units, or the layer may be more or less discontinuous representing a somewhat separated condition of the pulp units. The clearance, therefore, need not be necessarily uniform throughout the working area of a given pair of surfaces. It is in fact usually preferable in a machine of the type shown in Fig. 3 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. The minimum thickness of the layer in the working state is usually within the range of one-sixty-fourth to three-eighths of an inch, and obviously the operating clearance between the opposed working surfaces is equal to the thickness of the layer of pulp.

With the gyratory motion employed in the machines of this invention, each point of the working surface describes an individual path which is separate from and not superimposed upon the path of any other point of that surface, that is to say, no two points follow a common path throughout the full gyration cycle. The paths of all the points on a working surface are not necessarily identical in form either for a given surface or for different surfaces in different applications. Relative to the directly opposed working surface, the path described by any of the points represents a recurring, usually regular figure of two dimensions in the plane of relative tangential motion.

While it is usually advantageous to prevent rotation of the working surfaces, as is accomplished in the case of the machine shown in Figs. 1 and 3, in some adaptations of our invention one or both of the working surfaces may be unrestrained in respect to rotation, and we may even provide a controlled rotation. In operation, an unrestrained gyrating surface tends to rotate slowly, the speed of rotation depending in part on the speed of gyration, the working pressure, and the nature of the surfaces and the pulp under treatment. It will be further understood that both of the surfaces may gyrate in circular, elliptical or other gyration patterns.

It may be noted further that while the machines described have circular gyratory motion, if each of the opposed surfaces is reciprocated with straight line harmonic motion of equal amplitude in directions perpendicular to each other in the common tangential plane and in the proper phase relationship, the resulting relative tangential motion of the surfaces will be similar to the case of a circularly gyrating surface opposed by a stationary one, and will produce the desired results. It will further be understood that the desired tangential motion between the working surfaces may be obtained in other ways, either by moving one of the surfaces and causing the other to remain stationary or by moving both surfaces in different directions or in the same direction at different velocities.

Furthermore, it will be understood that instead of the machine being made as shown in Fig. 3 with the upper surface stationary and the lower working surface gyrating, the lower working surface may be fixed and provided with a central circular opening through which pulp may be fed continuously to the working space by means of a screw press or a screw conveyor mounted below the lower working surface and discharging directly to the opening. For such operation, the upper working surface will be gyrated continuously. The lower working surface will be kept in the fixed working position with the upper working surface either locked at a predetermined clearance or floating with a predetermined pressure on the pulp applied by the hydraulic means described above. The treated pulp will be discharged continuously from between the working surfaces at their outer edges where it may be collected for any desired utilization.

In the machine illustrated in Fig. 3, the feed is 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 to that from the central opening to the outer edge. Matched rectangular plates might, however, be used, as already indicated, in which one edge zone of 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. For treating pulp in our apparatus we may provide for a gyration frequency in the range of fifty to two thousand cycles per minute and for a relative tangential velocity in the range of fifty to five hundred feet per minute.

While the machine has been shown with a direct drive between the pulley 1 or 111 and the barrel 2 or shaft 114, it will be obvious that for greater flexibility and convenience, change gears may be provided or other similar means to permit adjustable variation in the gyration speed and amplitude. Moreover, the machine may, if desired, be equipped with means for measuring and recording the power which is used, the operating clearance between the working surfaces, and other significant factors.

When cyclical variation in clearance is employed, obviously there is a corresponding variation in the operating pressure which the working surfaces exert on the pulp under treatment. The movement of the working surfaces for variation in clearance is, of course, in a direction perpendicular to the main tangential motion of the surfaces due to the gyratory movement. The periodic changes in clearance and pressure seem to cause more rapid formation of nodules and rotating units thereof, and more complete and continual regrouping of the nodules and pulp units, particularly in cases where the starting material is in a more or less felted or unnodulated state. The transverse pulsations induced in the layer of processed material by the periodic variation in working clearance intensifies the drastic internal agitation produced by the tangential gyratory motion of the surfaces. The periodic variation in operating clearance provides also a further degree of control in the apparatus of the type shown in Fig. 3 for continuous processing of a flow of pulp, where the surfaces remain continuously in the operating position, since, by the proper choice of the amplitude and frequency of the variation of clearance, the rate at which the pulp is caused to progress through the operating zone may be rendered more responsive or less responsive, as desired, to the feeding pressure.

It will be obvious that instead of hydraulic means being employed for varying the clearance, mechanical means, such as the cam, may be used

instead. The amplitude of variation in clearance suitable for most applications is relatively small, usually under one quarter of an inch, but there are wide ranges of frequencies and of the time-displacement relationships of the movement which may serve for various applications. For example, frequencies of five to one hundred cycles per minute may be used. The time-displacement relationship may be of simple harmonic or more complicated forms to produce various combinations of the relative time period at which the surfaces are at minimum, maximum, receding and approaching clearances. Thus, for some applications it may be desirable to provide a relatively short period of maximum clearance or vice versa, or a relative rapid rate of opening the surfaces to maximum clearance or vice versa. For many purposes, however, a variation of clearance in simple harmonic movement of suitably chosen amplitude and frequency is highly effective.

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 previously described, no two points on a working surface relative to the opposed surface describe common paths in a full gyration cycle, thus insuring maximum criss-crossing of the paths of force and movement, and therefore the minimum of chance that any particle of the material can escape the force and move in a single path between the working surfaces.

While in the drawings, 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 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 general, it may be said that while the invention has been described in connection with different specific embodiments thereof, it is capable of further modification, and this application is intended to cover any variations, uses, or adaptations of the invention following, in general, the principles of the invention and including such departures from the present disclosure as come within known or customary practice in the art to which the invention pertains and as may be applied to the essential features hereinbefore set forth and as fall within the scope of the invention or the limits of the appended claims.

Having thus described our invention, what we claim is:

1. In apparatus for treating paper-making pulp, a relatively fixed plate having a working surface thereon, a support, a barrel rotatably journaled in said support and having an eccentric opening extending axially therethrough, a plunger journaled in said opening and free to reciprocate axially therein, a plate secured to said plunger and having a working surface formed thereon and arranged in opposed relation to the first working surface, each of said working surfaces being a basically plain surface but having tiny spaced protuberances projecting therefrom which provide traction for the pulp without obstructing rolling traverse of units of pulp on and over the surface means for rotating the barrel to effect bodily translatory movement of said second plate, means for cyclically reciprocating the plunger axially as the barrel rotates and means for holding the plunger against rotational motion during rotation of the barrel.

2. In apparatus for treating paper-making pulp, working elements having opposed working surfaces, each of which is a basically plain surface but is roughened to provide traction for pulp without obstructing rolling traverse of units of the pulp on and over the surface and means for imparting relative tangential motion between said surfaces comprising a rotatable barrel having an eccentric bore the axis of which is parallel to the axis of rotation of the barrel, an axially movable plunger journaled in said bore and connected at one end to one of said working elements, and means to prevent rotation of said plunger about its own axis comprising a pair of universal joints and an interconnecting link, one of said universal joints being attached to said plunger and the other universal joint being attached to a non-rotatable part of the apparatus.

3. An apparatus for processing papermaking pulp by traversingly rolling nodulated pulp under compression, which comprises a pair of working plates which have opposed working surfaces that define between them a relatively thin working space, each of said working surfaces being a basically plain surface but having tiny, spaced protuberances projecting therefrom into said working space which provide traction for the pulp without obstructing rolling traverse of units of the pulp on and over the surface, said protuberances having continuous peripheral surfaces, means pressing one of the plates toward the other to compress pulp between them, means for imparting a gyratory translatory movement to one of said plates about an axis extending in the direction of compression while the pulp is under compression, and means including a universal joint constraining said one plate so that during said gyratory movement all points in the working surface of said one plate trace separate, identical paths relative to the working surface of the other plate.

4. An apparatus for processing papermaking pulp by traversingly rolling nodulated pulp under compression, which comprises a pair of working plates which have opposed working surfaces that define between them a relatively thin working space, each of said working surfaces being a basically plain surface but having tiny, uniformly spaced protuberances projecting therefrom into said working space which provide traction for the pulp without obstructing rolling traverse of units of the pulp on and over the surface, said protuberances having continuous peripheral surfaces, fluid-pressure operated means for pressing one of the plates toward the other to compress pulp between the working surfaces, and means for imparting a relative circular translatory motion between said plates about an axis extending in the direction of compression so that all points in the working surface of one plate travel relative to the working surface of the other plate in separate circles of equal diameter.

5. In apparatus for processing papermaking pulp, a pair of working plates which have opposed working surfaces that define betweeen them a relatively thin working space, each of said working surfaces being a basically plain surface but having tiny, uniformly spaced protuberances projecting therefrom into said working space which provide traction for the pulp without obstructing rolling traverse of units of the pulp on and over the surface, said protuberances having continuous peripheral surfaces, said working surfaces being subtsantially parallel over appreciable portions of their opposed areas, an inlet disposed centrally of one plate and providing entry for pulp into the working space, a discharge zone around the periphery of one plate, fluid-pressure operated means for pressing one of the plates toward the other to compress pulp between the working surfaces, means, including a universal joint, for imparting a gyratory translatory movement to one of said plates about an axis extending in the direction of compression while the pulp is under compression, and means constraining said one plate so that during said gyratory movement all points in the working surface of said one plate trace separate, identical closed paths relative to the other working surface.

6. In a machine for processing papermaking pulp, a frame, a pair of plates having opposed working surfaces which are arranged to form therebetween a relatively thin working space, one of said plates being mounted on the frame to move freely toward and from the other, fluid pressure operated means for urging said one plate toward the other under predetermined pressure, an inlet disposed centrally of one working surfare, a discharge zone around the periphery of the working space, a rotary crank operatively connected to said one plate to impart movement thereto about an axis extending in the direction of pressure, and a plurality of rods equi-spaced about said axis, each rod being connected at one end by a universal joint to said one plate and being connected at its opposite end by a universal joint to the frame so that in the movement of said one plate all points of the working surface of said one plate will trace identical closed paths, said working surfaces having tiny spaced protuberances thereon which project only slight distances into the working space to provide traction for the pulp without obstructing rolling traverse of units of pulp on and over the working surfaces, and means for rotating said crank.

7. In apparatus for processing papermaking pulp, a pair of plates having opposed working surfaces which define between them a relatively thin working space, each of said working surfaces being a basically plain surface but having a plurality of tiny, spaced, conical protrusions projecting therefrom into said working space which provide traction for the pulp without obstructing rolling traverse of units of the pulp on and over the surface, fluid-pressure operated means for pressing one of the plates toward the other to compress pulp between the working surfaces, and means for imparting a gyratory motion to one of said plates about an axis extending in the direction of compression while the pulp is under compression.

8. In apparatus for processing papermaking pulp, a pair of plates having opposed working surfaces which define between them a relatively thin working space, each of said working surfaces being a basically plain surface but having a plurality of tiny, spaced, identical protrusions of regular quadrilateral pyramidal form projecting therefrom into said working space which provide traction for the pulp without obstructing rolling traverse of units of the pulp on and over the surface, fluid-pressure operated means for pressing one of the plates toward the other to compress pulp between the working surfaces, and means for imparting a gyratory motion to one of said plates about an axis extending in the direction of compression, while the pulp is under compression.

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References Cited in the file of this patent

UNITED STATES PATENTS

Number	Name	Date
47,425	Jones	Apr. 25, 1865
147,733	Yearsley	Feb. 17, 1874
321,451	Pond	July 7, 1885
657,206	Terrell	Sept. 4, 1900
748,867	Hodge	Jan. 5, 1904
877,640	Gent	Jan. 28, 1908
983,055	Hosmann	Jan. 31, 1911
1,065,332	Newhouse	June 7, 1913
1,165,033	Stobie	Dec. 21, 1915
1,627,506	Hamey	May 3, 1927
1,685,115	Adams	Sept. 25, 1928
1,795,603	Hussey	Mar. 10, 1931
2,035,994	Sutherland	Mar. 31, 1936
2,121,275	Zober et al.	June 21, 1938
2,172,704	Gentilli	Sept. 12, 1939
2,156,320	Sutherland	May 2, 1939
2,214,893	Von Hassel	Sept. 17, 1940
2,323,490	Scherff et al.	July 6, 1943
2,516,384	Hill et al.	July 25, 1950
2,561,013	Coghill et al.	July 17, 1951
2,599,543	Coghill et al.	June 10, 1952

OTHER REFERENCES

"Attritional versus Beater and Jordan Refining" by Roger B. Brown, published in Series 16 (1932–33) of the Tech. Asso. of the Pulp and Paper Industry, pages 294–296.