Sept. 27, 1955 E. H. CUMPSTON, JR 2,718,821

PULP REFINING APPARATUS AND METHOD

Filed May 25, 1953 4 Sheets-Sheet 1

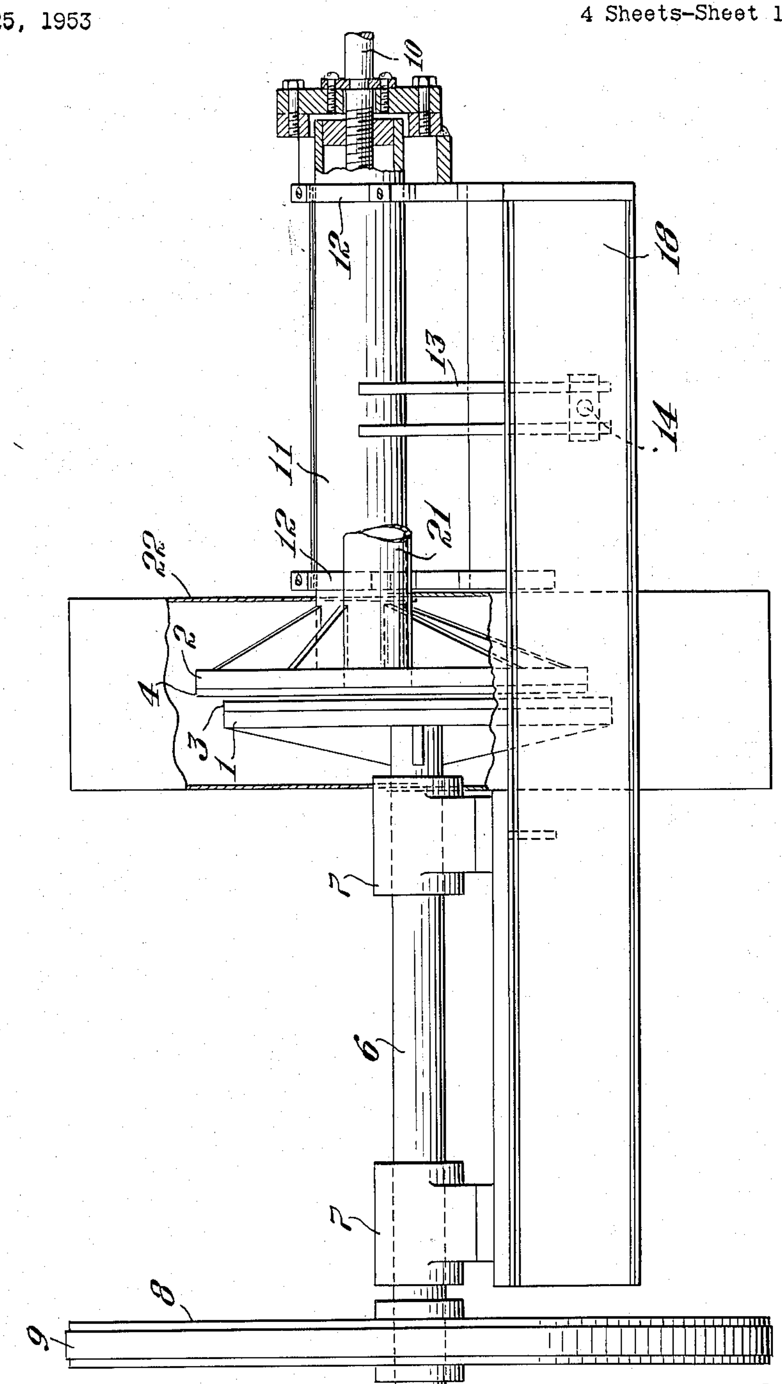

Fig. 1

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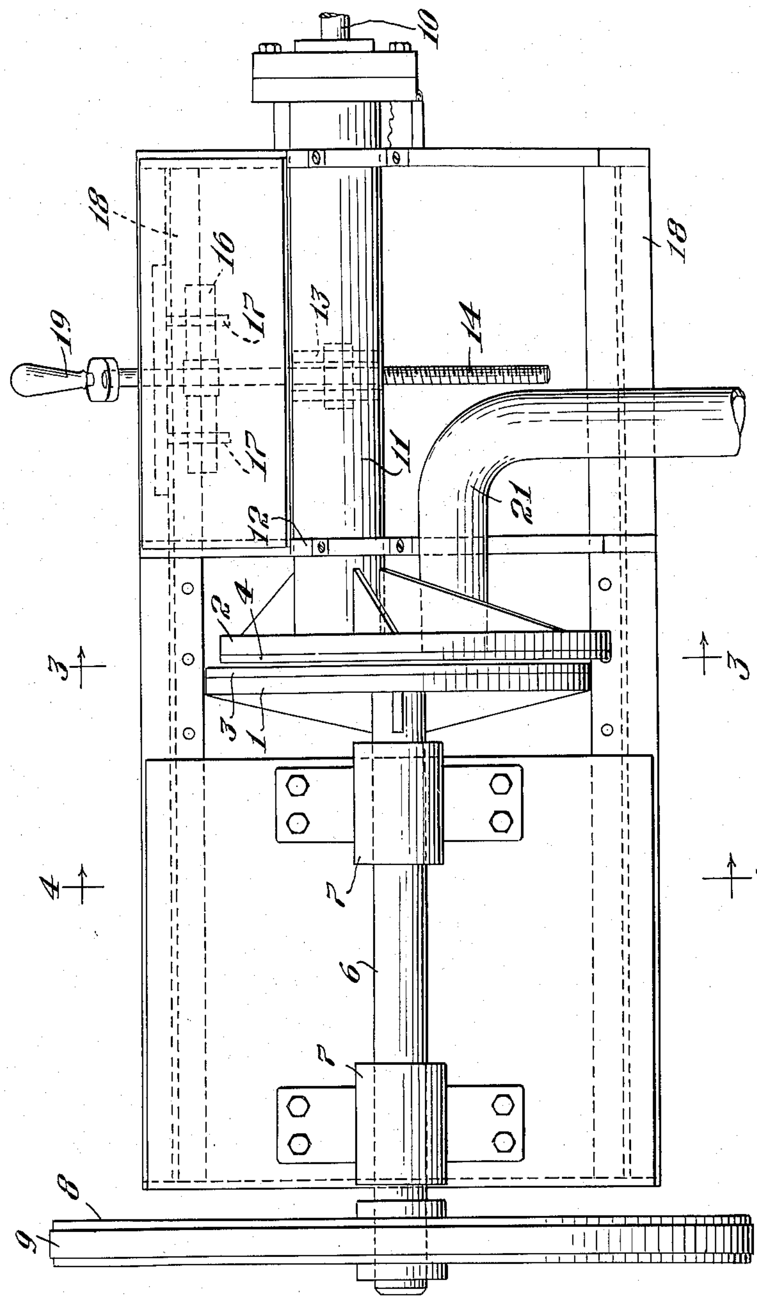

Fig. 2

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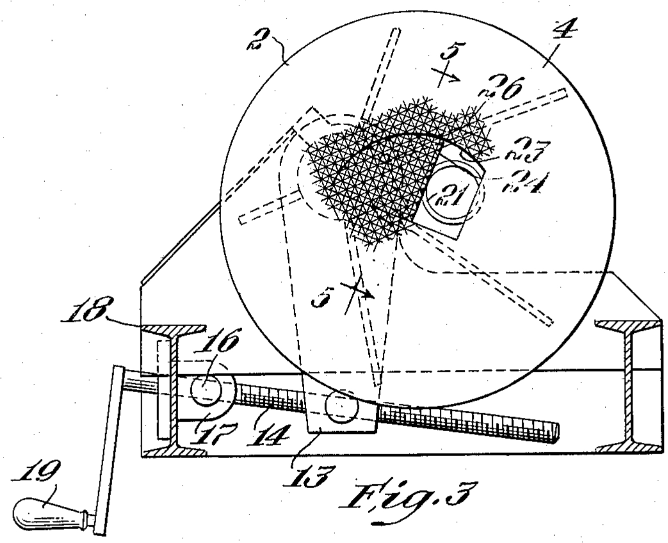

Fig. 3

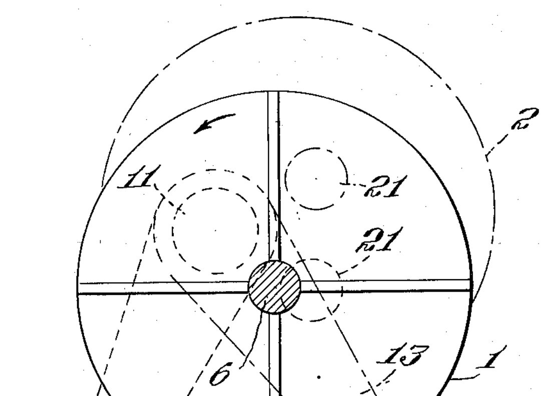

Fig. 4

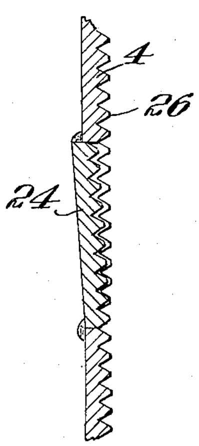

Fig. 5

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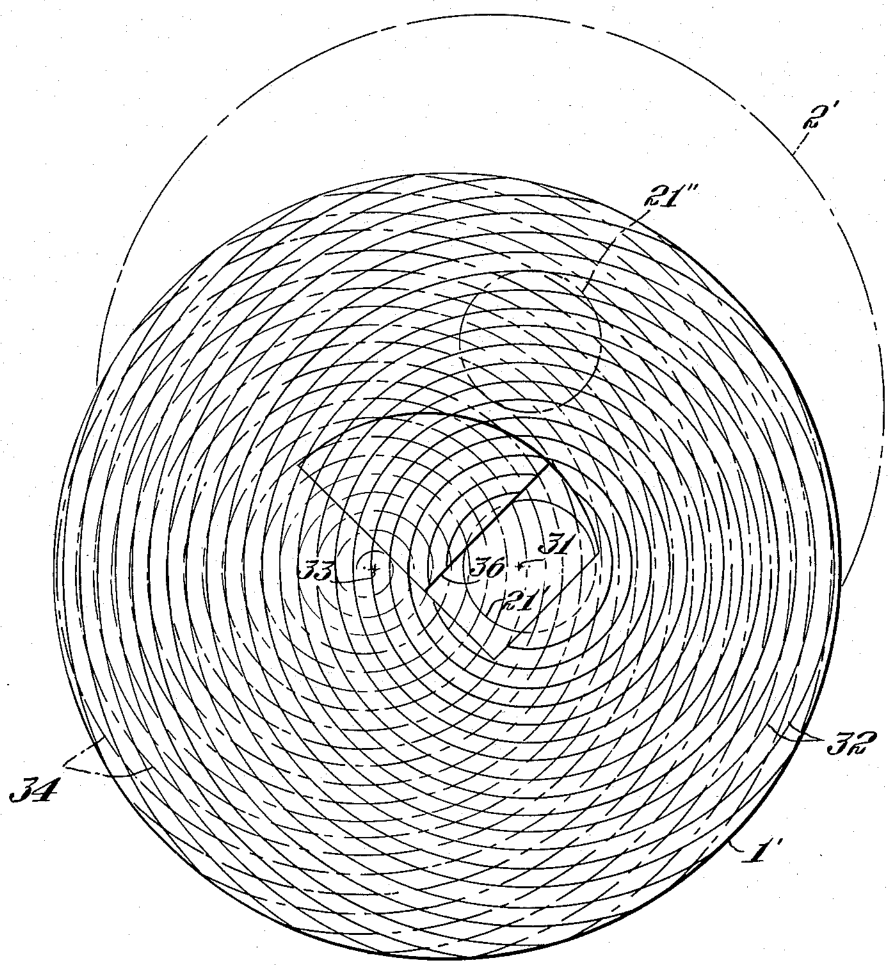

Fig. 6

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PULP REFINING APPARATUS AND METHOD

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Application May 25, 1953, Serial No. 357,220

14 Claims. (Cl. 92—26)

This invention relates to refining pulp, that is changing the structure of the fibers, in contradistinction to forming pulp by difibering before it is refined or changing the configuration of the fibers after they are refined.

Objects of the invention are to refine pulp more rapidly and more effectively to reduce the necessary power to handle pulp of high consistency, to eliminate the necessity of first dewatering the pulp, to produce a superior product, and generally to improve the art of pulp refining.

In one aspect the present invention consists in a method of refining pulp which comprises feeding the pulp into the space between two juxtaposed relatively rotatable surfaces having juxtaposed grooves extending transversely of the direction of rotation, dewatering the pulp in said space and forming the pulp into rolls, rolling the rolls between the grooved surfaces to refine the pulp, and discharging the water and pulp together throughout the periphery of said space.

In another aspect the invention consists in a pulp refining machine comprising two members having opposed surfaces one of which is rotatable relatively to the other in a predetermined circumferential direction around an axis, each of said surfaces having a set of juxtaposed grooves extending transversely of said direction with projections therebetween, and the grooves of the two surfaces extending transversely of each other, the included angle of the grooves approximating ninety degrees, and the number of grooves per inch being approximately five to ten, the projections being truncated to form relatively flat summits and the summits of the two sets being juxtaposed but far enough apart to clear each other when the space therebetween is empty, said space having an outlet throughout its entire periphery and an inlet through one of said members inside said periphery, whereby the pulp is dewatered in said space, the dewatered pulp is refined and both the pulp and the water are discharged through said outlet. The aforesaid projections should extend across that portion of one of said surfaces which is opposite said inlet. Preferably one of said members is stationary and the inlet extends through the stationary member. The width of the aforesaid summits of the projections should be less than approximately one-tenth inch. The projections are preferably divided into pyramids by another set of grooves extending transversely of the projections. The maximum dimension of the apex of each pyramid should not be greater than one-tenth inch. The opposed surfaces are preferably perpendicular to the axis of the rotatable member. The inlet to the space between the surfaces should be in the region of the aforesaid axis of rotation but offset from the axis of the member through which it extends. One of the members is preferably adjustable relatively to the other in a direction extending transversely of the aforesaid axis. The clearance between the aforesaid members should be approximately 0.010 inch to 0.20 inch.

For the purpose of illustration a typical embodiment of the invention is shown in the accompanying drawing in which

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Fig. 1 is a side view with the housing broken away;
Fig. 2 is a top plan view with the housing removed;
Fig. 3 is a section on line 3—3 of Fig. 2;
Fig. 4 is a section on line 4—4 of Fig. 2;
Fig. 5 is a section on line 5—5 of Fig. 3; and
Fig. 6 is a view like Fig. 3 showing a modification.

The particular embodiment shown in Figs. 1 to 5 comprises two juxtaposed disks **1** and **2** with serrated plates **3** and **4** mounted on their opposing faces. The disk **1** is fast to a shaft **6** journalled in bearings **7** and driven by a pulley **8** over which is trained a belt **9**. Disk **2** is mounted on a tube **11** journalled in bearings **12**. By means of a screw **10** the tube **11** may be moved endwise in bearings **12** for the purpose of adjusting the width of the space between the disks. The tube **11** may be turned about its axis by means of an arm **13** and screw **14**, the screw being rotatably mounted in a shaft **16** which is journalled in supports **17** on the frame **18**. As the tube **11** is moved lengthwise by screw **10** the shaft **16** slides lengthwise in its bearings **17**. The screw **14** may be rotated by means of a handle **19**. The disk **2** is mounted eccentrically on the tube **11** so that the disk **2** is concentric with the disk **1** when the arm **13** is in the full-line position shown in Fig. 4 and when the arm **13** is swung to the broken-line position in Fig. 4 the disk **2** occupies the position indicated by broken lines in that figure.

For feeding pulp to the space between the disk an inlet **21** is provided. When the two disks are concentric the inlet **21** is located near the axis of the rotating disk **1** as indicated by dash lines in Fig. 4 and when the arm **13** is swung to the broken-line position shown in Fig. 5 the inlet **21** is moved to the dot-and-dash position nearer the periphery of the rotating disk **1**. As the pulp enters the space between the two disks it feeds outwardly and is discharged throughout the entire periphery of the disks. A housing **22** is provided to limit the throw of the discharged pulp, the housing having an opening in the bottom through which the pulp may flow away.

The opposing faces of the working plates **3** and **4** are provided with juxtaposed grooves extending transversely of the direction of relative movement between the two disks, and in the preferred embodiment each of the opposing surfaces is provided with two sets of grooves extending transversely of each other. Thus in Figs. 1 to 6 each disk has two sets of straight grooves extending at right angles to each other to provide a plurality of pyramids **26** as shown in Figs. 4 and 5.

For the purpose of facilitating the entrance of the pulp to the space between the disks, the space immediately in front of the inlet preferably increases in width toward the inlet in the direction opposite to the direction of rotation of the disk **1**. This is preferably accomplished by providing an opening **23** in the facing **4** of the disk **2** and mounting in this opening a ramp in the form of a segment **24**, the serrated face of the bottom edge of the segment (Figs. 3 and 5) being flush with the serrated face of the facing **4** and the serrated face of the upper edge of the segment **24** being spaced farther from the serrated face of the plate **3** on the rotating disk **1**. Thus, with the disk **1** rotating in a counterclockwise direction, as indicated by the arrow in Fig. 4, the serrated facing **3** of the rotating disk drags the pulp to the left (Figs. 3 and 4) through a space of gradually decreasing width between the segment **24** and the face of the rotating disk.

In the modification shown in Fig. 6 only one set of grooves is provided on each disk facing and these grooves follow a spiral path. In the illustration the axis of the spiral groove of the stationary facing **1'** is located at **31** and the groove spirals outwardly in a counter-clockwise direction as indicated by the full lines **32**. The axis of the spiral of the rotating disk is located at **33** and the groove spirals outwardly in a clockwise direction as indicated by the broken lines **34**. When the two disks are concentric the axes **31** and **33** are located on opposite sides of the axis **36** of the disks and equidistantly therefrom. When the non-rotating disk is moved to the position shown at **2'** in Fig. 6, corresponding to the position **2** in Fig. 5, the inlet moves from the position shown at **21'** to the position indicated at **21''**.

When first starting the machine it is preferable to back the stationary disk away from the rotating disk to increase the spacing between the disk somewhat beyond the working range. When pulp is fed to the machine running in this condition it flows through without refining. Unlike prior refining machines, the serrations on the faces of the disks are too small to produce substantial turbulence of the pulp flowing through; therefore in this starting condition the machine draws no substantial power. After the machine is started in this condition the stationary disk is gradually adjusted toward the rotating disk and, when the spacing between the disks is reduced to the aforesaid working range, the machine draws power and refining begins.

As the pulp is pumped into the restricted space between the disks it starts to dewater and the dewatered pulp is dragged up the ramp **24** by the opposing serrations on the rotating disk. This further dewaters the pulp and the dewatered pulp is formed into rolls which progress spirally toward the periphery of the disks due to the combined action of rotation and centrifugal force. As the dewatering action progresses the pulp rolls become more firm and can be handled at the gradually increasing speed encountered as they progress spirally toward the periphery of the disks. By thus forming rolls the disks may be spaced apart much farther than in prior refining machines, thereby refining the pulp with comparatively little cutting of the fibers. The water squeezed out of the rolls flows freely to the periphery of the disk between the rolls and through the grooves in the faces of the disks. Pulp can be fed up to about ten per cent consistency, and is refined at up to fifty per cent consistency.

The refining action may be varied by moving the stationary disk closer to the rotating disk, which increases the action, or by shifting the stationary disk off-center relatively to the rotating disk, toward the position shown in broken lines in Fig. 4, which decreases the action because the spiral paths of the rolls from the inlet to the outlet are shorter. As the stationary disk is moved farther off-center the speed of the rotating disk opposite the inlet increases, and this permits the machine to be adjusted for different pulp conditions.

Owing to the size and shape of the disk grooving the working space is highly selective; it will hold fibers but will not hold water and it will not produce sufficient turbulence to keep fibers suspended in water. The absence of turbulence is evidenced by the lack of power demand when the space between the disks is increased to the point where rolls of fibers are not formed. Owing to this lack of turbulence, refining is accomplished with much less power than usual.

From the foregoing it will be evident that the machine of the present invention dewaters and refines the pulp in the same space, and it automatically feeds the pulp through the space. Features contributing to the success of the machine include the following. The inlet should be unrestricted. The inlet should be opposite to a moving working surface so that the entering pulp is dragged away from the inlet. The surface speed at the inlet should be adjustable to accommodate different pulp conditions. The relative surface speed at the inlet may vary widely depending upon the freeness of the pulp and the length of the fibers. When pulp is fed through the machine several times to refine it more each time, the speed at the inlet should be reduced for each successive pass through the machine in order to get maximum degree of refining in each stage. In refining cotton linters this speed is preferably of the order of 2500 to 500 feet per minute in successive passes. This variation of speed at the inlet can be quickly and easily effected throughout a wide range by the eccentric adjustment above described. The grooving of the working surfaces should have narrow refining edges or points to grip the pulp fibers but should not permit lodgment of high consistency pulp, and the grooving should permit free discharge of water without turbulence. If the grooves are too large or do not have sufficient flare, high consistency pulp tends to lodge in them; and if they are too small or too flaring, the refining action is low. The optimum size and shape are as above stated.

It should be understood that the present disclosure is for the purpose of illustration only and that this invention includes all modifications and equivalents which fall within the scope of the appended claims.

I claim:

1. A pulp refining machine comprising two members having opposed surfaces one of which is rotatable relatively to the other in a predetermined circumferential direction around an axis with all points in the one surface traveling in circles concentric with said axis, each of said surfaces having a set of juxtaposed grooves extending transversely of said direction with projections therebetween, the included angle of the grooves approximating ninety degrees, and the number of grooves per inch being approximately five to ten, the apices of said sets of projections being juxtaposed but far enough apart to clear each other when the space therebetween is empty, said space having an outlet throughout its entire periphery and an inlet through one of said members inside said periphery, the minimum clearance between said apices being approximately uniform throughout most of the region between said surfaces, and the location where the material enters said region being offset to one side of said axis, whereby pulp may be fed into said space continuously, the pulp is dewatered in said space, the dewatered pulp is refined and both the pulp and the water are discharged through said outlet continuously.

2. A pulp refining machine according to claim 1 further characterized in that said projections extend across that portion of one of said surfaces which is opposite said inlet.

3. A pulp refining machine according to claim 1 further characterized in that the width of the relatively flat summits of said projections is less than approximately one-tenth inch.

4. A pulp refining machine according to claim 1 further characterized in that the surface of the member having the inlet inclines away from the other surface toward the inlet immediately in front of the inlet to afford a tapered space for the ingress of pulp.

5. A pulp refining machine according to claim 1 further characterized in that said clearance is approximately 0.02 inch to 0.20 inch.

6. A pulp refining machine according to claim 1 further characterized in that said projections are divided into pyramids by another set of grooves extending transversely of the projections and the maximum dimension of the relatively flat apex of each pyramid is less than one-tenth inch.

7. A pulp refining machine according to claim 1 further characterized by means for adjusting the radial distance between said axis and location.

8. A pulp refining machine according to claim 1 further characterized by means for swinging one of the members about an axis parallel to said axis to adjust the radial distance between said axis and location.

9. The method of refining pulp which comprises continuously feeding the pulp into the space between juxtaposed relatively rotatable surfaces having juxtaposed grooves extending transversely of the direction of rotation, dewatering the pulp in said space and forming the

pulp into rolls, rolling the rolls between the grooved surfaces along spiral paths leading to the periphery of said space to refine the pulp and transport it to said periphery while maintaining the spacing between said surfaces constant, and continually discharging the water and pulp together throughout the periphery of said space.

10. A pulp refining machine comprising two members having opposed refining surfaces one of which is rotatable relatively to the other in a predetermined circumferential direction about an axis with all points in the one member traveling in circles concentric with said axis, one of said members having an inlet offset to one side of said axis, means for adjusting one of said members lengthwise of said axis to vary the clearance between the two surfaces, and means for adjusting one of said members relatively to the other member transversely of said axis to vary said offset.

11. A pulp refining machine comprising two opposed members having juxtaposed surfaces with protuberances thereon, means for rotating one member about an axis substantially perpendicular to said faces with all points in the one member traveling in circles concentric with said axis, said space having an outlet throughout substantially its entire periphery and an inlet through one of the members inside said periphery, the clearance between the protuberances being approximately uniform throughout most of the space between the surfaces, and the location where the material enters said uniform clearance space being offset to one side of said axis, whereby the pulp in said space is dewatered and formed into rolls which are rolled outwardly along spiral paths leading to said outlet.

12. A pulp refining machine according to claim 11 further characterized by means for adjusting the radial distance between said axis and inlet.

13. A pulp refining machine according to claim 11 further characterized in that said protuberances extend across that portion of the surface which is opposite to said location.

14. A pulp refining machine according to claim 11 further characterized in that the space between said surfaces gradually decreases from said inlet to said location.

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