May 10, 1960 H. BIDWELL 2,936,128

APPARATUS FOR THE TREATMENT OF PAPER STOCK

Filed Dec. 8, 1955 3 Sheets-Sheet 1

Fig. 1.

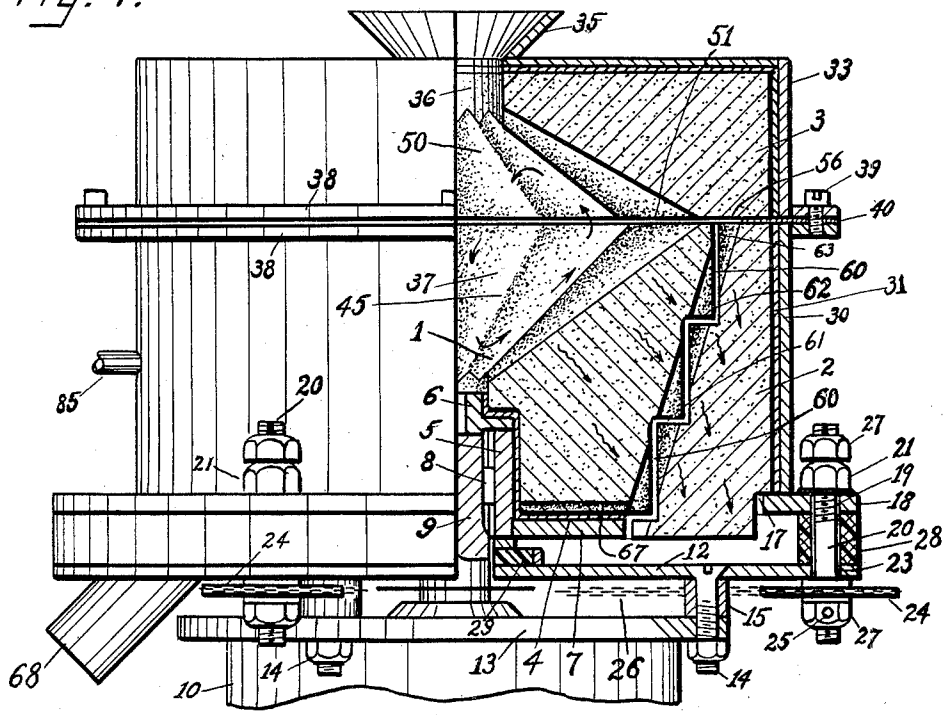



Fig. 2.

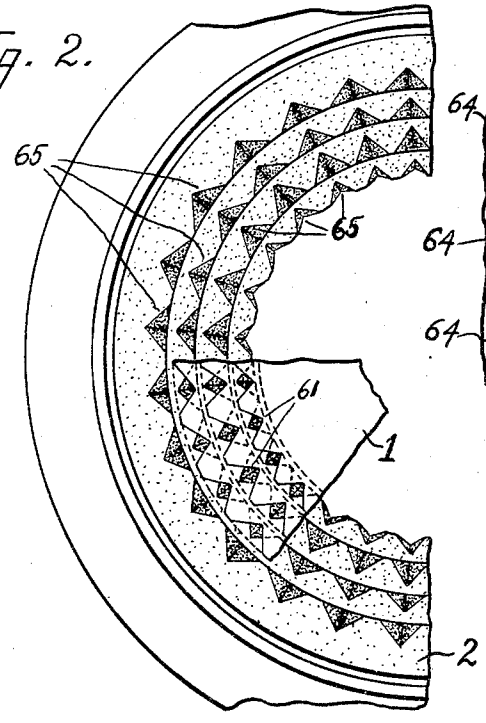
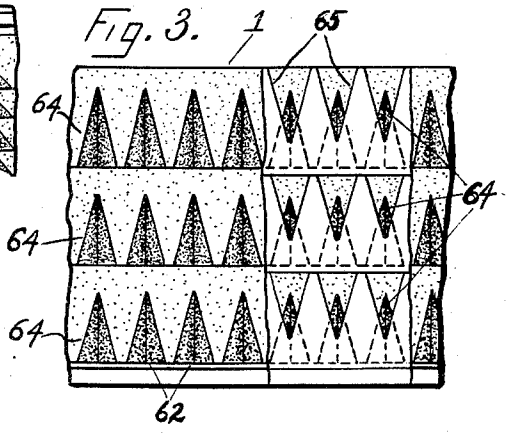



Fig. 3.




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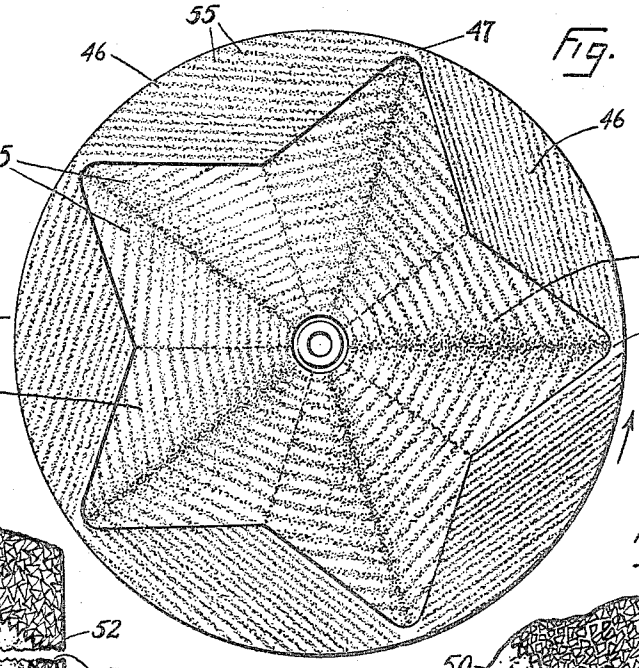



Fig. 4.

Fig. 6.

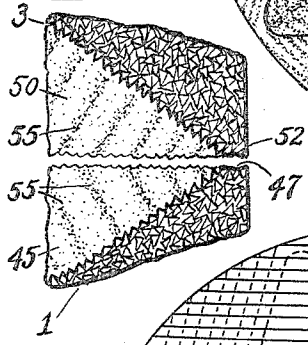
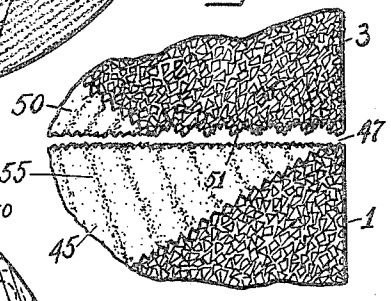
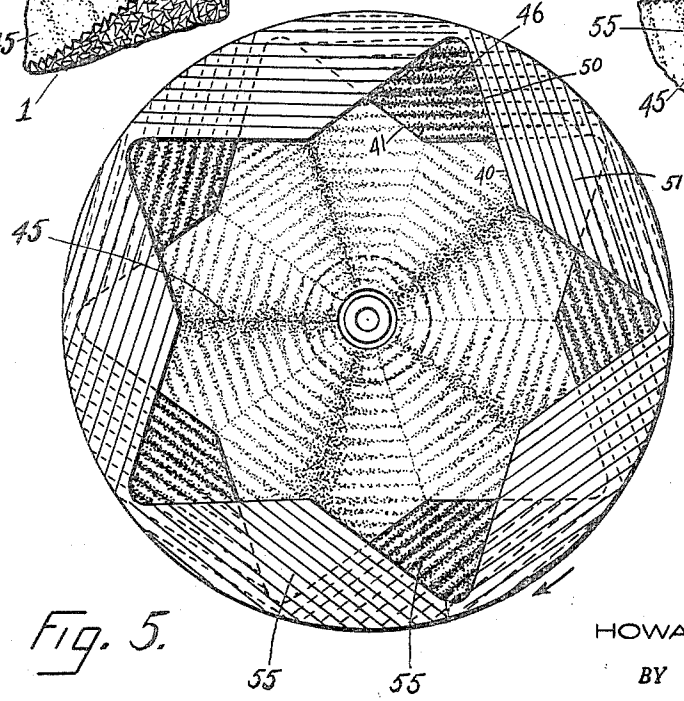



Fig. 7.



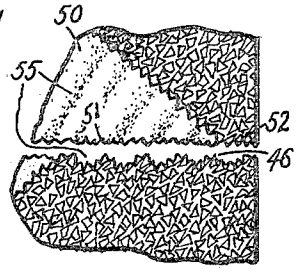




Fig. 8

Fig. 5.

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Fig. 9.

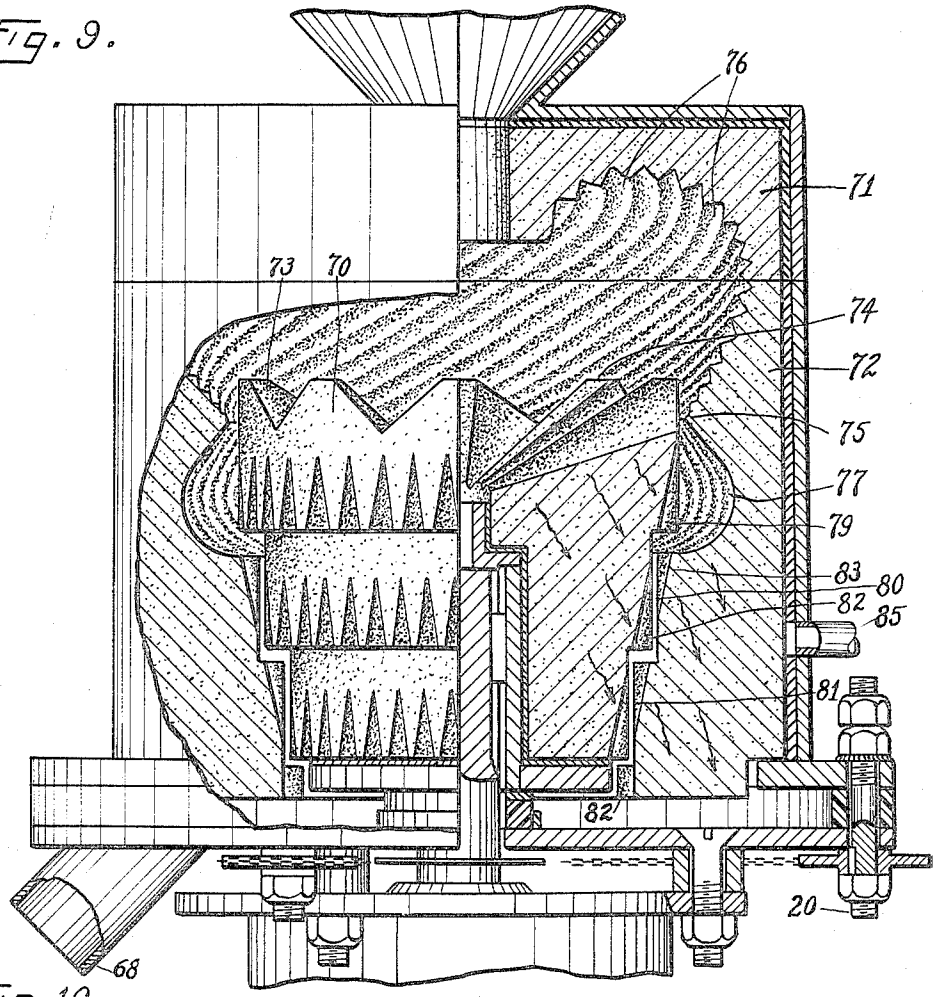
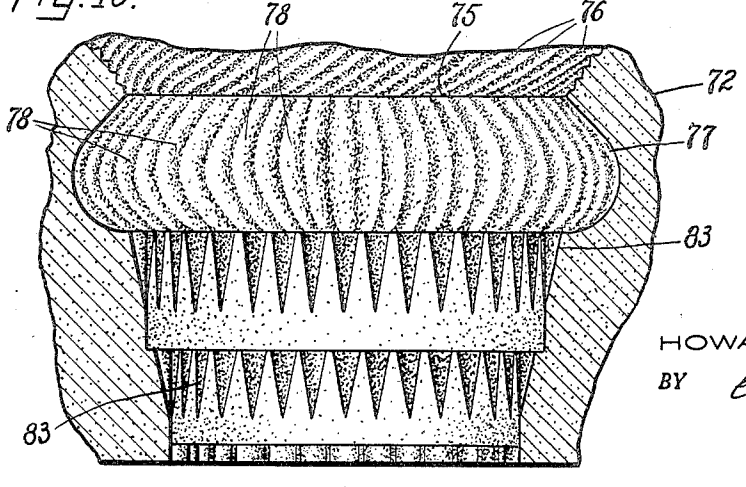



Fig. 10.




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United States Patent Office 2,936,128 Patented May 10, 1960



2,936,128

# APPARATUS FOR THE TREATMENT OF PAPER STOCK

Howard Bidwell, Granby, Mass.

Application December 8, 1955, Serial No. 551,845

11 Claims. (Cl. 241—157)

This invention relates to an improvement in apparatus for separating the fibres from paper stock aggregate and fibrillating the separated fibres by means of the combing action of a granular surface or surfaces.

This application is a continuation in part of my copending application Serial No. 187,765, filed September 30, 1950.

One object of the present invention is to provide means of the above character making a more efficient use of the combing action of the granular surfaces on the aggregate and the fibres. A further object is to provide arrangements of such surfaces particularly adapted to the treatment of rag stocks. Other and further objects residing in the details of the arrangement of such surfaces will be made apparent from the disclosure of the accompanying drawings and from the following specification and claims.

In the accompanying drawings,

Fig. 1 is an elevational view, partly in section of a machine embodying the invention;

Fig. 2 is a fragmentary plan view of the stator of Fig. 1;

Fig. 3 is a fragmentary elevational view showing a portion of the working peripheral surface of the stator with a portion of the opposing surface of the rotor being shown in phantom;

Fig. 4 is a plan view of the rotor;

Fig. 5 is a view similar to Fig. 4 but showing the under surface of the cover member of the stator diagrammatically superposed thereon;

Figs. 6, 7 and 8 are diagrammatic fragmentary views showing the relationship of the opposing contours of the upper surface of the rotor and the opposing under surface of cover member of the stator in three positions of rotation of the rotor;

Fig. 9 is an elevational view, partly in section, showing a modified arrangement; and

Fig. 10 is a fragmentary view showing the working surface of the stator of Fig. 9.

Referring to Fig. 1, the rotor is shown at 1 and the stator is shown as comprising an annular member 2 and an annular cover member 3.

The rotor 1 is cemented or otherwise secured as at 4 to a hub member 5 which includes flange members 6 and 7, the hub member being splined as at 8, or otherwise connected, to the shaft 9 of a vertical motor, indicated at 10 for rotation thereby.

The stator members 2 and 3 are supported by a plate 12 mounted on the top plate 13 of the motor casing by means of bolts 14 and spacers 15.

Stator member 2 is shouldered at 17 to rest on and be supported by a ring 18 adjustably supported by plate 12. As shown ring 18 is provided with a plurality of circumferentially spaced openings 19 through which respective jack screws 20 extend into threaded engagement with nuts 21 welded to the ring 18. Three jack screws 20 spaced 120° apart (two being shown in Fig. 1) extend downwardly through respective openings 23 in plate 12 and carry sprockets 24 fixed to the jack screws as by



splines or other suitable means not shown. The several sprockets 24 are connected by a sprocket chain 26 for simultaneous adjustment of the jack screws. Lock nuts 27 are provided to releasably lock the jack screws in position, the lower parts 27 being fixed to the jack screws as by pins 25.

The jack screws pass through a ring 28 interposed between ring 18 and plate 12. Ring 28 with a sealing ring 29 positioned adjacent shaft 9 form a chamber into which the stock is discharged as later described.

Member 2 is surrounded by a metal casing 30 to which it is secured in any suitable manner as by cement 31 and cover member 3 is similarly secured in a casing 33. Casing 33 is provided with a funnel 35, communicating with an opening 36 in cover member 3, through which material to be processed may be introduced to the chamber 37 formed between the rotor 1 and the cover member 3 of the stator. Casings 30 and 33 are provided with respective flanges 38 connected by screws 39 to hold the members 2 and 3 in proper relation, a suitable gasket 40 being positioned between the members 2 and 3 and flanges 38.

Rotor 1 and stator members 2 and 3 are formed of a porous granular material, such for example as that described in copending application Serial No. 187,765, providing granular surfaces adapted to comb individual fibres from the water borne stock aggregate as the latter flows over the surfaces. The arrangement shown in Figs. 1 to 8 inclusive are particularly adapted for the separation and fibrillation of textile fibres from rag stock.

The inner surface of the rotor 1 is contoured, as best shown in Fig. 4 to provide a plurality of upwardly and outwardly inclined, and flaring V-shaped valleys 45, which terminate in a flat surface in a plane at right angles to the axis of rotation of the rotor to form generally triangular, flat areas 46 between the upper ends of valleys 45, the areas 46 as shown being connected by relatively narrow surfaces 47 adjacent the periphery of the rotor.

The inner surface of stator member 2, as shown in Fig. 1, is contoured in a manner similar to, but opposite, the contouring of the rotor to provide a plurality of downwardly and outwardly inclined, and flaring V-shaped valleys 50, corresponding to valleys 45 of the rotor, and terminating between generally triangular surfaces 51, corresponding to surfaces 46 of the rotor, surfaces 51 as shown being connected by relatively narrow surfaces 52, corresponding to surfaces 47 of the rotor. The surfaces 47 and 52 may be omitted to permit the valleys 45 and 50, respectively, to discharge to the periphery of the rotor, if desired.

The opposed, contoured faces of the rotor and stator member 3 are preferably striated with relatively shallow, narrow grooves as indicated at 55 in Figs. 4 to 8 inclusive, these grooves being too small to be effectively shown in Fig. 1 are omitted in that figure. As shown in Fig. 4 the grooves 55 in the walls of valleys 45 of the rotor are parallel from the ridges which separate the valleys to the bottom of the valley. The grooves 55 on the surfaces 46 are arranged parallel to each other and to the leading edge of the surfaces 46 when the rotor is rotated in the direction of the arrow in Fig. 4.

Considering the operation of the device as so far described, the rag aggregate introduced to chamber 37 through opening 35 and coming in contact with the whirling rotor is driven by centrifugal action upwardly and outwardly along the valleys with increasing velocity and against and upwardly and over the advancing ridges between the valleys. As the aggregate reaches the upper outer end of a valley 45, if the exit of the valley coincides with the entrance of a valley 50 of the stationary cover member as shown in Fig. 6, the stock passes into and over the surface of the coinciding valley 50 and over the surface of the contours of the stationary cover mem-

ber and back to the center of the rotor as indicated by the arrows in Fig. 1. As the rotor rotates to a point where the point of minimum coincidence of the exits and entrances of the valleys 45 and 50 respectively, as shown in Figs. 5, 7 and 8, the stock seeking exit from the valleys 45 is for the most part intercepted by the overhanging "triangular" surfaces 51 and is in part abruptly thrown back toward the rotor and in part carried, with a combing action across the triangular surfaces 51 until the valleys again come into coincidence. While there is thus a general circulation of the stock in the direction of the arrows in Fig. 1 this circulation is constantly modified by the action just described producing a constant shifting and turning of the aggregate so that all parts are brought into free moving but unconfined contact with the combing action of the granular surfaces resulting in a rapid reduction of the size of the aggregate and the separation of individual fibres therefrom.

As the aggregate particles are reduced to appropriate size they enter into the space between the surfaces 46 and 51 of the rotor and stator, respectively. Fig. 5 shows the striations or grooves 55 on the surfaces 46 and 51 in broken and full line respectively, where the one underlies the other. As will readily be seen these grooves criss-cross each other at varying degrees of angularity as the rotor rotates, and this changing relative direction of the grooves 55 in the granular surfaces imparts a drawing or pulling action on the fibres of the aggregate effectively drawing out the most resistant types of woven fibres from aggregate such as hard fabrics.

While the spacing of the rotor and stator surfaces will be varied by the adjusting mechanism above described to meet the requirements of different types of textiles and textile fibres being processed the spacing should permit sufficient freedom of movement of the aggregate between the surfaces so that no appreciable crushing or cutting forces are imposed on the fibres by the granular surfaces, the latter surfaces acting to comb and pull individual fibres from the aggregate whether the latter is dry or water borne.

The contours 45, 50 and 55 effect a vigorous combing of the fibrous mass during the movement over, to and from and between the stator and rotor, the effectiveness of the combing action being materially increased by the fact that the angularity of the contours never remain at the same angle with respect to the material being combed. Also because of the ever changing angularity of the contours carried by the stator and rotor with respect to each other possibility of fibres tending to bundle and roll is eliminated since there is no unison in the relative movement of these contours. Further, due to the pulling effect on aggregate particles by the ridges separating grooves 55 any particles not reduced to component yarns and threads have a tendency to be drawn or driven back toward the center of the rotor. Separated fibres within the grooves pass to the perimeter of the rotor, and through the annular passage 56 provided between the upper face of the rotor and the lower face of the stator member 3.

Referring again to Fig. 1 the peripheral face of the rotor is shown spaced from the inner surface of the annular stator member 2 to provide an annular passage through which the stock, discharged at the perimeter of the rotor, passes downwardly. This passage comprises annular vertical portions 60 and annular horizontal portions 62, the latter portions being formed by successive reductions in the diameter of the rotor and corresponding successive reductions in the inner diameter of the annular stator member 2. The opposed faces of the rotor 1 and stator member 2 forming the walls of passage 60 are contoured to effect further processing of the fibrous stock.

In the embodiment shown in Figs. 1, 2 and 3 the contouring of the rotor, best shown in Fig. 3, takes the form of downwardly directed angular valleys 64 formed in the peripheral faces of the rotor, the valleys 64 commence below the upper edges of the respective portions of the rotor faces in which they are formed, the depth of the valleys increasing toward the lower ends of the valleys, the lower ends opening to the horizontal passages 61. The opposing faces of stator member 2 are provided with spaced angular valleys 65, the upper ends of which open from the passage 56 and the successive passages 61 and decrease in depth downwardly terminating short of the lower edges of the respective portions of the stator face in which they are formed.

The valleys 64 and 65 form chambers in the walls of passages 60 which as the rotor rotates to bring the valleys 64 and 65 successively into and out of opposition to each other successively increases and decreases the effective width of the passages 60 from a maximum equal to the spacing of the ungrooved portions of the stator and rotor members plus the sum of the depth of the valleys at their overlapping portions, to a minimum equal to the spacing of the uncontoured portions. This constant change in the size of the passage which takes place rapidly since the rotor rotates at a relatively high speed effects a rapid transfer of the stock, in part at least, from one chamber to the next, thus drawing out the fibres of the stock during the transfer from one chamber to the other, in its downward passage. Further, the decreasing diameter of the successive annular passages 60 decreases the overall cross-sectional area of the passages and reduces the rate of downward flow of the stock with the result that it is retained in the passages and chambers for a longer time. Within these relatively small chambers the separated fibres are subjected to an intense combing by the granular surfaces of the chambers and passages resulting in the most complete separation of the stock into its elemental fibers and the fibrillations of the fibers themselves.

By changing the amount of decrease in the diameter of the passages 60, that is the radial width of the passages 61, the time of retention in the passages and chambers can be controlled to meet the needs of substantially any kind of stock, and, as will be apparent, passage of the stock can be speeded up by successively increasing rather than decreasing the diameter of the annular passages 60, that is "stepping" the passages 61 radially outwardly instead of inwardly, if maximum rate of flow is desired. As will also be apparent the rate of flow of the stock through the passages 60—61 and valleys 64—65 also to a large measure determines the rate of flow through the stock through the machine as a whole. The rate of flow depends to some extent on the quantity of water used. A dry aggregate is frictionally retarded in its passage over all of the granular surfaces. As greater lubrication is afforded by an increase in the amount of water employed frictional retardation decreases up to the point where the aggregate is substantially completely water borne.

Control and variation in the lubricating effect of the water phase of the stock is afforded by the porosity of the granular material of the rotor and stator members. Due to this porosity there is a constant withdrawal of water (as indicated by the arrows in Fig. 1) from the stock in contact with and passing over the upper surface of the rotor, which withdrawal tends to draw the aggregate into closer and more effective combing contact with the granular surface. This water withdrawal is increased by centrifugal forces resulting from the rapid rotation of the rotor. As will be apparent the water thus passing through the rotor is for the most part discharged into the passages 60—61 and chambers 64—65 through the peripheral surface of the rotor. If found desirable radial channels, as indicated at 67 may be formed in the lower face of the rotor to channel any water reaching the bottom of the rotor outwardly to the edge of the supporting flange 7.

The porosity of the stator member 2 permits water to seep from the passages 60—61 and valleys 64—65. The loss of water from the latter passages and chambers is less than that gained, and the increasing fluidity of the

stock in the lower chambers and passages facilitates its discharge from the machine and subsequent handling. The processed stock is discharged through one or more outlet pipes 68.

In Figs. 9 and 10 the refining and fibrillating chambers and stepped passages are shown applied to an embodiment more particularly adapted to the processing of chemical pulps.

In the construction of Figs. 9 and 10 a rotor 70 and stator members 71 and 72 formed of granular surfaced material are supported, and the rotor driven, in a manner essentially similar to that previously described. In this latter form the upper surface of the rotor is shown as contoured by radially extending V grooves 73 having intervening flat topped ridges 74, substantially similar to the contouring shown in certain embodiments disclosed in the above identified application of which this is a continuation in part. The stator member 72 is formed with an inwardly extending knife edge 75 which acts to "trim out" the more completely processed stock which is discharged from the bottom of the grooves in the manner also described in the above identified copending application. The inner surface of the portion of stator member 72 above the knife 75 and the inner surface of stator member 71 is contoured with grooves 76 which direct the stock above the knife upwardly and inwardly to the center of the rotor, for recycling by the rotor.

The discharge of the stock from the contours of the rotor enters an annular chamber 77 which is contoured as at 78 in a manner generally similar to that of the stator members above the knife edge to direct the stock against the opposite peripheral surface of the rotor. The latter surface is provided with downwardly flaring valleys or recesses 79 similar to valleys 64 previously described, except that the valleys 79 are shown with rounded bottoms instead of V-shaped bottoms. Below the valleys 79 the diameters of the rotor and stator members are decreased, as in the structure previously described, the valleys opening above and in spaced relation to the inner lower edge of chamber 77.

Below the chamber 77 the opposed faces of the rotor and stator are spaced to provide the annular passages 80 and 81, stepped inwardly, and the faces are provided respectively with downwardly and upwardly flared valleys 82 and 83 similar in form to valleys 79 and forming chambers functioning to effect a variable flow of the stock as described in connection with the valleys 64 and 65.

In addition to the fibrillation which takes place in the valleys 82—83 below chamber 77 the retardation of the flow causes the stock to be retained for a longer time in the chamber 77 where the action of valleys 78 and 79 effects a rapid generally spiral circulation of the stock and a vigorous combing of the fibres which assures complete fibre separation and fibrillation of the fibres.

In the form of Figs. 1 to 8 a series of three chambered passages are provided, while in the form of Figs. 9 and 10 a series of two such passages is provided below the chamber 77. However, a greater or less number may be provided as the nature of the stock or other processing conditions make desirable.

Also, instead of vertical rotor peripheral and stator faces, these may be inclined or tapered so that the clearance in the passages 60—61 and 82—83 may be varied throughout their length by adjustment of the jack screws 20.

While the contours 64, 65, 79, 82 and 83 are shown vertically directed they may be inclined at a leading or lagging angle relative to the axis of rotation of the rotor.

If desired a pipe connection 85 may be provided through which steam may be admitted to the porous stator to raise the temperature of the fibres being processed.

What is claimed is:

1. A machine for separating the fibres from a waterborne paper stock aggregate and fibrillating the separated fibres by means of the combing action of granular surfaces, over and between which the stock aggregate is caused to flow which comprises a granular surfaced rotor the granular surfaces of said rotor including a substantially cylindrical peripheral surface and an annular, granular surfaced stator, the upper surface of the rotor being contoured with radially upwardly and outwardly flaring grooves terminating adjacent the periphery of the rotor in a plane surface at right angles to the axis of the rotor, the surface of the stator above the rotor being contoured with outwardly and downwardly flaring grooves terminating in a plane surface parallel to and spaced from the said planar peripheral portion of the upper surface of the rotor and forming therewith a restricted annular flow passage to the perimeter of the rotor, said planar surfaces being striated with shallow grooves, said shallow grooves in the stator and rotor lying at different angles to exert a pulling action on the stock aggregate within the passage, upon rotation of the rotor, the stator including a portion radially spaced from the peripheral surface of the rotor to form an annular passage therebetween opening downwardly from said first-named passage, the surfaces forming said second passage being contoured to vary the flow characteristics of the latter passage.

2. A machine for separating the fibres from a waterborne paper stock aggregate and fibrillating the separated fibres by means of the combing action of granular surfaces, over and between which the stock aggregate is caused to flow which comprises a granular surfaced rotor the granular surfaces of said rotor including a substantially cylindrical peripheral surface and an annular, granular surfaced stator, the upper surface of the rotor being contoured with radially upwardly and outwardly flaring grooves terminating adjacent the periphery of the rotor in a plane surface at right angles to the axis of the rotor, the surface of the stator above the rotor being contoured with outwardly and downwardly flaring grooves terminating in a plane surface parallel to and spaced from the said planar peripheral portion of the upper surface of the rotor and forming therewith a restricted annular flow passage to the perimeter of the rotor, said planar surfaces being striated with shallow grooves, the shallow grooves in the stator and rotor lying at different angles to exert a pulling action on the stock aggregate flowing through the passage, upon rotation of the rotor, the peripheral surface of the rotor and opposing wall of the stator being spaced to form a second passage; the opposed walls of the rotor and stator forming said second passage being comformably stepped to divide said passage into successive portions of different diameter to impart varying capacities to said portions, the rotor and stator surfaces forming said portions being formed with recesses positioned to be brought into and out of opposition to each other upon rotation of the rotor to intermittently vary the flow characteristics of the passage portions.

3. A machine for separating the fibres from a waterborne paper stock aggregate and fibrillating the separated fibres by means of the combing action of granular surfaces over and between which the stock aggregate is caused to flow which comprises a granular surfaced rotor and an annular, granular surfaced stator, the upper surface of the rotor being contoured with radially upwardly and outwardly flaring grooves terminating adjacent the periphery of the rotor in a plane surface at right angles to the axis of the rotor, the surface of the stator above the rotor being contoured with outwardly and downwardly flaring grooves terminating in a plane surface parallel to and spaced from the said planar peripheral portion of the upper surface of the rotor and forming therewith a restricted annular flow passage to the perimeter of the rotor, said planar surfaces being striated with shallow grooves, the shallow grooves in the stator and rotor lying

at different angles to exert a pulling action on the stock aggregate flowing through the passage, upon rotation of the rotor.

4. A machine for separating the fibres from a water-borne paper stock aggregate by means of the combing action of granular surfaces, over and between which the water-borne aggregate is caused to flow; which comprises, a granular surfaced rotor and a granular surfaced stator having respective opposed peripheral surface portions spaced from each other to provide a flow channel therebetween, said peripheral surface portions being each provided with recesses spaced from each other in the direction of relative movement of the rotor and stator and positioned to be brought into and out of opposition to each other upon rotation of the rotor, said recesses being generally triangular in cross section and of decreasing depth and width in a direction substantially at right angles to the direction of relative movement of the rotor and stator.

5. A machine for separating the fibres from a water-borne paper stock aggregate by means of the combing action of granular surfaces, over and between which the water-borne aggregate is caused to flow; which comprises an annular granular surfaced stator, a granular surfaced rotor rotatable about a vertical axis within said granular surfaced stator, the latter having a surface portion extending inwardly over the outer portion of the upper surface of the rotor and spaced therefrom to form an annular flow channel therebetween, said portions being each provided with radially extending recesses decreasing in depth and width in the direction of the outer edge of said annular flow channel.

6. A machine for separating the fibres from a water-borne paper stock aggregate by means of the combing action of granular surfaces, over and between which the water-borne aggregate is caused to flow; which comprises an annular, granular surfaced stator, a granular surfaced rotor rotatable about a vertical axis within said granular surfaced stator, said rotor and stator having opposed respective, cylindrical peripheral surface portions concentric with the axis of rotation of the rotor and spaced from each other to form a vertical annular flow channel, said opposed surfaces being each provided with circumferentially spaced axially directed recesses, the respective recesses in said stator and rotor increasing longitudinally in depth and width in opposite directions.

7. A machine for separating the fibres from a water-borne paper stock aggregate by means of the combing action of granular surfaces, over and between which the water-borne aggregate is caused to flow; which comprises an annular, granular surfaced stator, a granular surfaced rotor rotatable about a vertical axis within said granular surfaced stator, said rotor and stator having opposed respective, cylindrical peripheral surface portions concentric with the axis of rotation of the rotor and spaced from each other to form a vertical annular flow channel, said opposed surfaces being each provided with circumferentially spaced axially directed recesses, the respective recesses in said stator and rotor increasing longitudinally in depth and width in opposite directions, the stator having a surface portion extending inwardly over the outer portion of the upper surface of the rotor and spaced therefrom to form an annular horizontal flow channel opening to the upper end of said vertical flow channel, said last-mentioned portions of the rotor and stator surfaces being each provided with radially extending recesses decreasing in depth and width in the direction of the juncture of the horizontal and vertical flow channels and positioned to be brought into and out of opposition with each other upon rotation of the rotor.

8. A machine for separating the fibres from a water-borne paper stock aggregate by means of the combing action of granular surfaces, over and between which the water-borne aggregate is caused to flow; which comprises an annular, granular surfaced stator, a granular surfaced rotor rotatable about a vertical axis within said granular surfaced stator, said rotor and stator, respectively, having a succession of cylindrical surface portions concentric with the axis of the rotor and of successively smaller radius, said cylindrical surfaces and the surfaces connecting them, of the rotor, being spaced from the corresponding surfaces of the stator to form a generally vertical flow channel, the said cylindrical surface portions of the rotor and stator being each provided with axially directed recesses positioned to be brought into and out of opposition with each other upon rotation of the rotor, the respective recesses in the stator and rotor increasing in depth and width in opposite directions.

9. A machine for separating the fibres from a water-borne paper stock aggregate and fibrillating the separate fibres which comprises a rotor and an annular stator over and between which the stock is caused to flow, the surfaces of said stator and rotor, over and between which the stock flows, being provided with flow directing grooves, said rotor and stator being formed of a porous granular material providing the rotor and stator with overall granular surfaces, the porosity of said material biasing the aggregate toward overall contact with said abrasive surfaces as the stock flows thereover.

10. In a machine for separating the fibres from paper stock aggregate and fibrillating the separated fibres which includes a rotor and stator having respective overall granular surfaces, said surfaces being spaced from each other to provide an annular passage therebetween and characterized in that said surfaces are striated, the striae in the stator and rotor lying at different angles to exert a pulling action of the stock aggregate upon rotation of the rotor.

11. In a machine for separating the fibres from paper stock aggregate and fibrillating the separated fibres which includes a rotor and stator having respective overall granular surfaced peripheral portions, said peripheral portions being spaced to provide an annular flow passage therebetween and characterized in that said peripheral portions are respectively provided with recesses spaced from each other and positioned to be brought into and out of opposition to each other upon rotation of the rotor, to intermittently vary the flow characteristics of said annular passage.

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