

Nov. 20, 1962

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3,064,908

APPARATUS FOR MIXING AND WORKING MATERIAL

Filed June 27, 1958

2 Sheets-Sheet 1

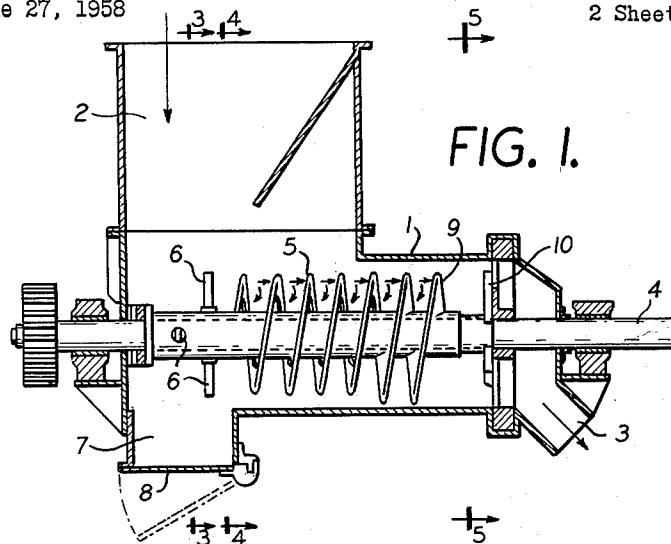


FIG. 1.

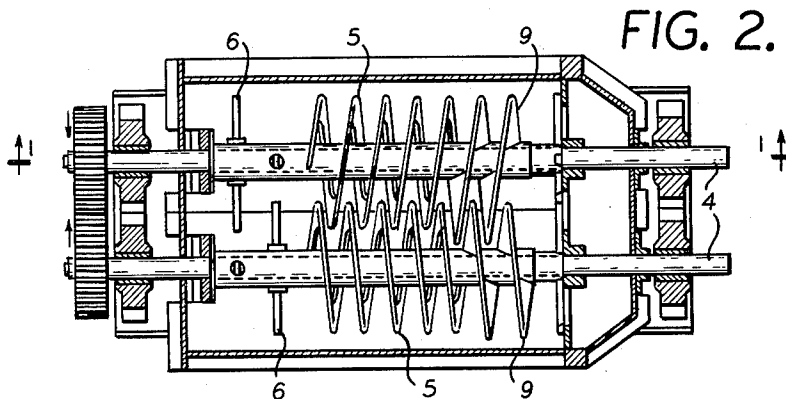


FIG. 2.

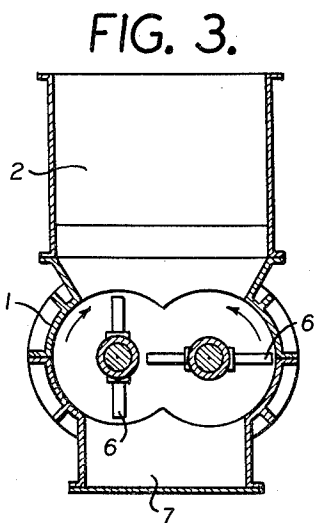


FIG. 3.

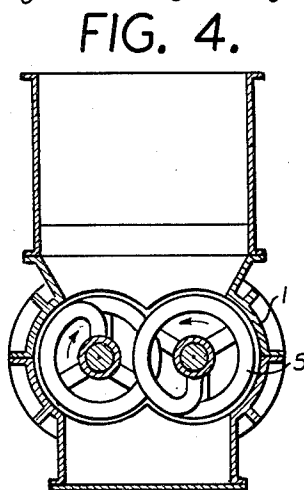


FIG. 4.

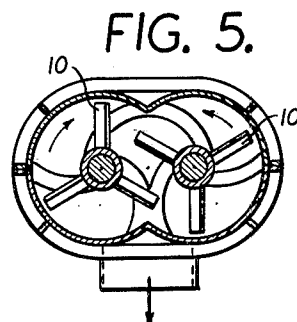


FIG. 5.

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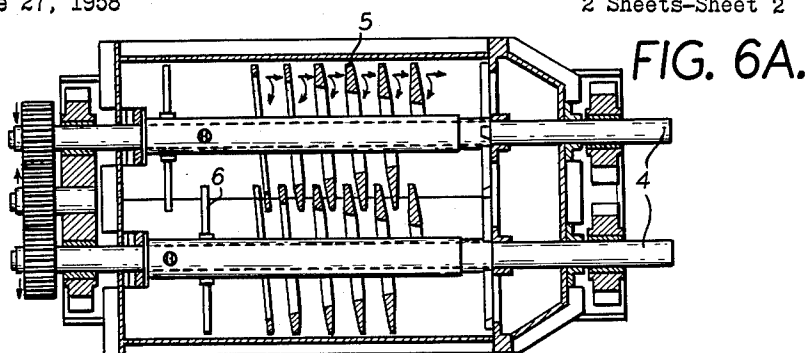
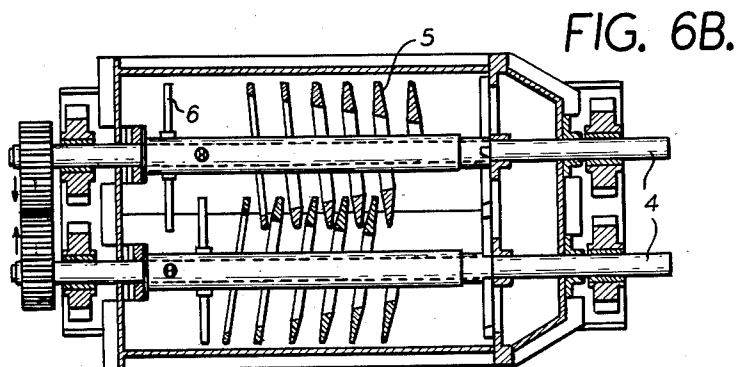


FIG. 7.



FIG. 8.



FIG. 10.

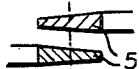


FIG. 11.

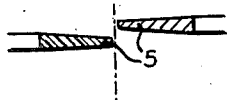


FIG. 13.

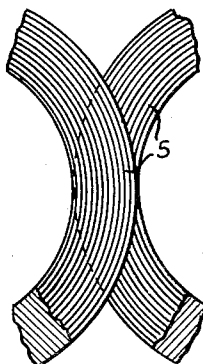
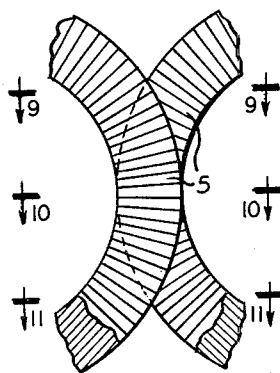


FIG. 12.



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APPARATUS FOR MIXING AND WORKING
MATERIAL

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9 Claims. (Cl. 241—252)

The invention relates to a device for performing working steps on a particular material, especially solid particles which are suspended throughout a medium e.g. a liquid. Peat, cellulose and in particular paper pulp are among those materials which are advantageously treated in accordance with the invention.

The treatment performed in accordance with the invention has fundamentally the character of a mixing treatment but may under certain circumstances also involve disintegration, comminution, milling, condensation, dewatering and similar treatments, each of these treatments or combinations of such treatments at the same time having the character of a material transport or discharging step. It is also possible that chemical reactions take place under suitable conditions offered by the treatment.

In the working of raw materials and intermediary products in various technical fields, such as in the cellulose and paper industry, in the chemical, ceramic or metallurgical industries, or in milling plants and the like, the materials to be worked as a rule are successively subjected to a plurality of different treatments of the above types. For certain purposes it may be of importance simultaneously to mix and convey the material while, for other purposes, it may be necessary to combine, for example, mixing, condensing and milling. As far as fibrous material such as pulp is concerned it may, for example, be necessary to beat the material in such a way that at the same time a defibration effect is obtained. Related technical problems are encountered when non-homogeneous material is to be pulverized or when the treated material comprises substances of different consistencies such as solid, viscous or liquid matter. Moreover, it may be desired in connection with joint comminution or mixing of a plurality of substances to allow a chemical reaction to take place in or between the components. After a treatment of the material it may also be desired to extrude the finally treated material through a shaping aperture or to introduce the material into packaging containers for shipping or sale. In many cases the technical solution of these problems has offered difficulties because, as a rule, it has been necessary to perform a plurality of successive working steps in a corresponding series of different devices.

In the cellulose and paper industry, defibrating treatments yielding a more or less uniform pulpy product are generally performed by means of pug mills, hollander beaters, Jordan mills or the like, each of these devices having its specific favourable and unfavourable properties. During many decades of technical developments these devices have substantially maintained their original construction and way of working and improvements have been made only with regard to constructive details.

The pug mill in which two stones are rolling on a lower stone is a heavy, large and bulky machine having very low capacity and requiring excessive space. The operation is batchwise and the mixing effect is poor whereby a non-uniform product is obtained. When moist fibrous material is treated in the pug mill the mechanical work performed is of a turning and kneading character combined with a pulsating hydraulic effect whereby a defibration of coherent fibre bundles and weakening of the capillaries in the material is obtained. This combined milling

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effect in the pug mill has proved particularly advantageous in the production of so-called craft pulp. In the operation of the pug mill comparatively small amounts of water are required. Mills of the pug mill or edge runner type are of course used also in fields other than the pulp and paper field.

The hollander beater comprises an open trough in which a cylinder is rotating in such a way that cutting edges disposed on the cylinder cooperate with a stationary edge in the trough. This type of beater has been developed specifically for use in the paper making industry. The construction of the hollander beater requires the fibrous material to be slurried in such an amount of water that a grout-like consistency is obtained. With the aid of the rotating cylinder the pulp is circulated through the trough which is in the form of an oval flow channel, the pulp thus being passed repeatedly through the milling gap between the stationary edge and the edges provided on the cylinder. However, the inner circumference of the flow channel is considerably shorter than the outer circumference whereby uneven working of the fibrous material is caused. Also the hollander beater is operated batchwise which means that considerable volumes of material must be kept flowing. The hollander beater is a bulky machine consuming much power and requiring considerable space.

One of the main advantages of the hollander beater resides in the fact that its working members and operational data may be adapted to a great extent to such desired properties of the pulp as are required in order to obtain certain different types of paper.

By designing the Jordan-mill, which is a slow-working cone mill, it has been attempted to arrive at a continuously operating apparatus in order to eliminate the disadvantages inherent in batchwise operation. However, the Jordan-mill is not fully satisfactory for many reasons and in actual practice it has often been necessary to resort to combinations of the various milling and beating means. Also the Jordan-mill requires the addition of considerable amounts of water.

In the manufacture of fibre board the defibrator-type of apparatus is presently used to a great extent for working the fibrous material. The defibrator operates in a continuous manner, the fibrous material passing between grooved rotating discs. No high-grade quality product is obtained by means of the defibrator.

In the above-mentioned pulp working devices the beating or defibration effect is obtained by exposing the material particles to the action of cooperating milling elements, the adjusted mutual spacing of which is decisive for the degree of beating or defibration obtained. It is an important desideratum in the beating and defibration of pulp that a high degree of beating, i.e. an extensive subdivision of the material into individual fibres is not accompanied by any considerable decrease of fibre length. In this respect, however, all the apparatus types mentioned above are not fully satisfactory because particularly heavy beating or defibration, as a rule, is accompanied by a considerable reduction of the average fibre length. The problems illustrated here in connection with fibrous materials are typical for those encountered in modern industry, in particular automation aspects where during continuous intensive working of particulate or suspended materials avoidance of deteriorating effects is a generally encountered problem.

In all the cases in which the present invention will give beneficial results there is involved a continuous or batchwise treatment of a particulate or suspended mass of material for the purpose of achieving a homogeneous mixture, a conveying effect or a working modifying the particle structure or state of suspension being aimed at simultaneously with the mixing effect.

In accordance with the invention the material treated is passed through a working path, comprising the spaces between the cooperating surfaces of at least two relatively movable members, the material in these interspaces being subjected to pressure pulses which are propagated in the material between mutually corresponding points on the cooperating surfaces.

For obtaining a circulatory movement within the material involving a plurality of passages of every portion of the material through the working path it is advantageous to cause the material to flow in a return path adjacent the working path in a reverse direction in comparison with the general direction of flow through the working path to points where the recirculated material is again introduced into the working path.

In the entire average working path traversed by an arbitrary portion of the material treated each of said pressure pulses gives rise to a rhythmically varying sequence of pressure thrusts and pressure reductions propagated in the material.

In suspended materials or materials containing moisture the pressure pulse to a great extent is of a hydraulic character. Due to this, fibrous material treated according to the method of the invention will undergo a considerable defibration, the transfer of the pressure via moisture occluded or held by capillary forces within the material particles being the most active factor for disrupting the particles along the natural fissuring lines of the fibre bundles.

The pressure level from which the active pressure pulses start may be generally elevated or may be variable—increasing or decreasing or both locally increasing and decreasing—along the length of the working path.

A device according to the invention comprises a housing having inlet and outlet openings, working members being rotatably disposed in said housing on shafts driven in mutual dependency. According to the invention the working means are in the form of flanges extending about the shafts or the axes of said shafts, the radially outermost edges of said flanges extending in a screw or spiral line about the respective shafts, the spacing between each point on the circumference of one of the flanges and the centre line of the corresponding shaft being greater than the minimum spacing between the same point and the centre line of the shaft or shafts of the other flange or flanges, the flanges on different shafts thus mutually extending into each other's bodies of revolution, the pitch of the spiral or screw winding of the flanges being such that a certain minimum spacing is maintained everywhere between such portions on different flanges which mutually extend into each other's bodies of revolution.

In a preferred embodiment of the device the edge of each flange which is closest to the centre line of the respective shafts is spaced from said shaft or the centre line thereof whereby a free space is formed interiorly of the working zones formed by the bodies of revolution of said flanges.

It is an object of the present invention to provide apparatus for the simultaneous performance of a mixing treatment in combination with other treatments of a conveying or material disintegrating character.

A more specific object of this invention is to provide apparatus for performing a beating treatment in connection with the preparation of paper pulp and similar products, such beating treatment being more efficient and less violent than conventional treatments.

Other objects and advantages will appear from the following description.

The accompanying drawings show for the purpose of exemplification without limiting the invention and claims thereto certain practical embodiments illustrating the principles of this invention. In the drawings:

FIG. 1 is a vertical sectional view, on the line 1—1 of FIG. 2, through one embodiment of apparatus according to the invention;

FIG. 2 is a horizontal sectional view of the apparatus shown in FIG. 1;

FIGS. 3, 4 and 5 are transverse vertical sectional views of the apparatus, taken along the correspondingly numbered lines of FIG. 1;

FIGS. 6A and 6B are horizontal sectional views, generally similar to FIG. 2, illustrating two different driving arrangements for the cooperating helical bands;

FIGS. 7 and 8 are sectional views through cooperating helical bands, illustrating different forms of cooperating surface configurations;

FIGS. 9, 10 and 11 are sectional views, through the helical bands, taken on the correspondingly numbered section lines of FIG. 12; and

FIGS. 12 and 13 are partial elevational views, partially in section, of cooperating helical bands illustrating two different arrangements of grooves in the surfaces thereof.

Referring to FIGS. 1 to 5 the apparatus shown there comprises a housing 1 in which the particulate material to be treated is introduced through a funnel-like inlet 2. After treatment within the housing the material is discharged through an outlet 3 at the end of the device opposite to the inlet 2. Two parallel shafts 4 extend longitudinally of the housing between the inlet and outlet. The shafts are journaled and geared for equal and mutually dependent rotation in mutually opposite directions. The journalling and gearing means as well as means (not shown) for driving the shafts at a comparatively high speed of the order of 100 to 1000 r.p.m. are fully conventional and do not appear to require detailed description. The shafts 4 carry working members 5 which are in the form of flat bands extending in screw or spiral form about each of said shafts and having their longer lateral dimension directed substantially radially. One of said helical bands is left-handed and the other one right-handed. In the embodiment shown the pitch of the helical bands extending into each other's bodies of revolution is decreasing towards the outlet but it is to be understood that in other embodiments the pitch may be uniform if such is desirable in view of the working effect to be obtained.

The pitch of the helical bands 5 is further so chosen that a predetermined minimum spacing is obtained throughout the working zone between the mutually overlapping portions of the helical bands.

In the embodiment illustrated in FIGS. 1 to 5 shafts 4 further carry a plurality of rod elements 6 by means of which any undesirable particles of excessive size are sorted out towards a collecting space 7 at the bottom of the casing for removal through a discharge opening normally covered by a lid 8. Elements 6 may be constructed as impeller elements so that they simultaneously serve to feed the material inserted through inlet 2 towards the working members.

At the outlet end each shaft 4 is provided with a helical screw blade 9 which takes part in the rotational movement of the working members and the shaft, the screws 9 on both the shafts 4 also extending into each other's bodies of revolution in the same way as the helical bands. The screws serve to eject the treated material from the device through the outlet 3.

Moreover, the shafts 4 at the outlet end carry knives 10 adapted to crush any over-sized particles left in the treated material after passage through the working zone around and between the helical band.

Neither the screws 9 nor the knives 10 form necessary parts of a device according to the invention and such screws and knives are provided only in such embodiments in which on account of the desired working result a unidirectional transport effect or a cutting and/or grinding action is required. On the other hand, the helical bands 5 represent the working members which are characteristic of the invention and which are required in order to obtain the very specific effect aimed-at by the invention. According to FIGS. 1 to 5 the outer edges of the helical bands

are disposed close but not contiguous to the inner wall

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surfaces of the housing. The inner edges of the helical bands are not in contact with the respective shafts but are spaced from the surface of the shaft thus providing a substantially unobstructed space within the helical bands about the shaft. The helical bands are of course rigidly connected to or journaled on their respective shaft 4 but the supporting or journalling means (which may be of a type shown, for example, in U.S. Patent No. 1,608,200, issued to Cheyne) will not substantially restrict the free flow path provided inwardly of the inner edges of the helical band about the respective shafts.

The device described above with reference to FIGS. 1 to 5 will operate as follows:

The material supplied through the inlet 2 is pretreated by impeller rods 6 for removing undesirably thick parts and for feeding the rest of the material towards the helical bands 5. At the inlet end either helical band will act as an ordinary screw conveyor having a typical degree of filling and conveying capacity. In the embodiment shown in which a right-hand helix and a left-hand helix are rotating in mutually overlapping relationship the material is caught between both bands in the zone of intermesh and the material is thereby directed inwardly towards the centre of either screw. Outward flow of the material is restricted by the walls of the housing. Hereby the degree of filling of the conveyor screws is increased. This process is repeated once for each turn of the screws as the helical bands rotate and the material is fed towards the outlet. Due to the reduced pitch of the screws the material is progressively compressed whereby initially the degree of filling is further increased and finally the space within and about both the helical bands is completely filled with material.

Upon engagement between the helical bands an amount of material corresponding to the volume of the engagement zone is displaced towards the centre of each helical band whereby increased degree of filling and increased pressure is obtained and accordingly there will be increased friction between the rotating surfaces and the treated material.

By modification of the constructive properties of the helical bands optimum efficiency may be obtained for various materials and in respect to different working treatments. Important factors in this respect are the width, thickness, pitch, cross-sectional shape and least mutual spacing of the helical bands, the ratio between band area and return flow area inwardly of the helical band etc. In addition to these constructive modifications control of certain operational factors may be resorted to in order to modify the working result, such operational factors being the rate of rotation of the helical bands and the damming-up and condensation of the material within the apparatus e.g. by restriction of the outlet area by means of valve means (not shown).

Some possible modifications of the construction of the helical bands are illustrated in FIGS. 6A and 6B, each showing the working elements of a device having two mutually intermeshing helical bands. In FIG. 6A, the bands are supported on shafts 4 which are driven in the same rotational direction whereas, in FIG. 6B, the bands are supported on shafts which are driven in opposing rotational directions. Both helical bands have decreasing pitch from the inlet side (to the left in the drawing) towards the outlet side. The width of the bands, i.e. their radial dimension, is increasing in the same direction. As the outer diameter of the bands is constant the increasing width of the bands means a progressive restriction of the free flow inwardly of the inner edge of each band whereby a progressive increase in return flow pressure is obtained due to the progressive increase towards the outlet end of the compressive forces acting on the material and the restriction of the backward flow space about the shaft. The general directions of movement of a material through the device are indicated by the arrows in FIGS. 6A and 6B.

The helical bands of the embodiments according to

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FIGS. 6A and 6B are also modified with regard to their cross-sectional shape which a parallelogram at the inlet end but which in a progressive transition changes towards the outlet end into an outwardly tapering wedge or trapezoid form.

If a device of the type shown in FIGS. 1 through 6B is used as a pulp beater the least spacing between the helical bands in the zone of intermesh is considerably greater than the average particle size of the material, apart from such coarse particles or knots as may exceptionally be present and which may have a greater diameter and accordingly may be subjected to a clipping or shearing action between cooperating helical band surfaces. With regard to the main portion of the fibrous material which initially consists of chip fragments or fibre bundles in admixture with already isolated fibres the working effect performed by means of the helical bands is not predominantly due to direct friction between working surfaces and material particles but in the first place an indirect, pulsating hydraulic action occurring in the zone of intermesh between the helical bands and leading to an effective defibration of the particles due to a combination of mechanical compression and hydraulic pressure developed in the moisture occluded or held within the material by capillary action. In this application the device is considerably more efficient than any comparable prior art devices because the complete defibration to a certain desired final degree requires only a fraction of the power consumed by conventional devices, the final product in addition being distinguished by an average fibre length far in excess of that obtainable by prior art methods. The superiority of the present process as far as average fibre length is concerned may be easily explained by the fact that no clipping or shearing action between cooperating cutting or milling elements is exerted and accordingly there is no longitudinal tearing of the fibres. In other words, the beating may be continued almost indefinitely without involving the risk of considerably reducing the average fibre length in connection with the maximum degree of defibration.

A beating process performed with the aid of a device according to the invention may be continuous or batch-wise. For example, it is possible to restrict the outlet to such an extent that a high degree of internal circulation of the material within the device is obtained, the process being conducted in a continuous manner by continuously supplying the same amount of material to the inlet as is discharged through the restricted outlet.

When using the present device as a beater or defibrator in the cellulose or paper industry the helical bands are operated at revolution rates ranging from 100 to 1000 r.p.m. Satisfactory working results have been obtained in a machine constructed in accordance with the present invention and operated at a speed of 400 r.p.m. For other purposes such as dehydration involving a considerable concentration of solid matter within the machine during operation the speed range is lower, preferably lower than 150 r.p.m., and revolution speeds as low as 10 r.p.m. have been successfully used in practice.

The following table gives an idea of the exceptionally good working results obtained in the beating of paper pulp by means of a device according to the invention. The table illustrates the way in which various properties of a paper made from the beaten pulp are dependent on the duration of treatment in the apparatus:

Beating period, minutes	0	5	10	15	20
Degrees SR ¹	13	15	16	19.8	24.3
Pull-off length ²	1,700	3,900	4,400	4,600	4,700
Extension factor	1.2	3.4	3.7	4.2	3.8
Tear resistance	92	103	103	99	93
Burst resistance	8	34	37	42	41
Dry matter contents	8.7	13.1	12.7	12.7	13.6

¹ Schopper-Riegler.

² Length of freely hanging strip of uniform width required for gravity pull to break.

The following table shows the low power consumption in comparison with conventional beating systems measured in connection with the treatment according to the preceding table. In spite of a comparatively high power consumption of the apparatus during idling the total power consumption shows favourable values and the net power consumption is extremely low.

Beating period, minutes	5	10	15	20
Total power cons., kwh./1,000 kg. paper-----	105	210	315	420
Power cons. on idling, kwh./1,000 kg. paper--	45	90	135	180
Net power cons., kwh./1,000 kg. paper-----	60	120	180	240

When an increased frictional effect is desired and the material is not liable to be damaged by a more intensive working the surface of the helical bands may be provided with grooves, e.g. undulate, as shown in FIG. 7, or saw-toothed, as shown in FIG. 8. The grooves may extend radially of the band surfaces, as shown in FIG. 12, or concentrically circumferentially of the band surfaces, as shown in FIG. 13. Various groove profiles and directions may be combined. It is possible to use such profiles on the band surfaces in combination with constructive modifications of the bands described in connection with FIG. 6.

Dependent on the field of use the helical bands may consist of various materials such as stainless steel, bronze or other acid or alkali resistant material.

FIG. 9 illustrates the way of working of the helical bands in the zone of intermesh during operation. The section A—A shows how the band surfaces approach each other for mutually overlapping cooperation. Section B—B is taken at the position of maximum overlap between the helical bands. At the position for section C—C the compressive coaction between the helical bands has come to an end. The pulsating operation which is characteristic of the present apparatus is obtained within the zone of intermesh between the bands, the extent of this zone clearly appearing from FIGS. 10 and 11, the most powerful pressure pulse of course appearing on and around the position of section B—B whereby material carried between the helical bands in the direction of rotation thereof is exposed to a momentarily rising and falling pressure pulse during passage through the zone of intermesh. Due to the general construction of the device and the working conditions involving comparatively fast rotation of the helical bands and a circulatory return flow of material through the free space about the shafts every part of the material will be subjected several times in rapid succession for this pressure pulse action which in the case of suspended or moisture-containing material has a hydraulic character.

In the practice of the present invention the material or different materials to be mixed are fed into the inlet in the direction of the arrow in FIG. 1. It is also possible to feed different materials in succession rather than simultaneously.

If a device is to be used as a mixer only, the pitch of the helical band need not be decreasing towards the outlet and unless the material is dammed up by restriction of the outlet no general condensation or concentration of the material will take place in addition to the pulsating pressure pulses occurring in the zone of intermesh between the helical bands. However, these pressure pulses which are propagated through the material already involve an intimate mixture of the material, the duration of the working and thereby the finally obtained degree of mixing being adjusted by suitable control of such factors as are decisive for the period of time during which the material is retained in the device, such factors being the degree of restriction of the outlet and the ratio between the free space inwardly of the helical bands and the working space within the bodies of revolution of the helical bands.

If the device is intended to perform a comminuting or

compressing work the screws or helical bands preferably have variable pitch (decreasing or increasing or a combination of sections with increasing or decreasing or constant pitch). In the embodiments according to FIGS. 1 and 2 or 6 in which the pitch of the screws decreases towards the outlet, due to the great spacing between the band turns near the inlet end, there will be an important initial conveying effect towards the outlet. As the spacing between the turns decreases there will be a progressively more powerful compression of the material. Within the zone of overlap or mutual intermesh between the helical bands an amount of the material corresponding to the band sections and band spacings in that zone will be displaced towards the free space interiorly of the helical bands. Hereby the pressure prevailing in the material will be increased in comparison with that prevailing at the inlet end and the acceptance of additional material within the range of the screws will be restricted to the amount that is definitely withdrawn from the apparatus.

Towards the outlet end the material is compressed into a more or less homogeneous mass extruded under comparatively heavy pressure.

Due to the cross-sectional shape of the helical bands shown in FIGS. 6A and 6B some kind of wedging effect is obtained between the cooperating band surfaces whereby an additional increase of the milling or beating pressure and—upon close spacing—of the frictional effect is obtained. When beating operations are performed on moisture-containing fibrous material a working is obtained of the type explained above, this working being related to that obtained in a pug mill where there is also some kind of hydraulic action through which capillarily occluded water is squeezed out whereby the capillaries are disrupted. As previously maintained, however, the effect obtained by means of the present device is far superior to that obtained in a pug mill. The main reason for this superiority is assumed to be the free mobility of the material in the present device in which due to the fast rotation of the helical bands and the conveying, compressing and return flow actions caused thereby every portion of the material is exposed to the working action between mutually overlapping band portions at a frequency which is many times greater than that at which the working pulse recurs in a pug mill in respect to every individual portion of the material. In the pug mill it is not even certain that material portions introduced centrally of the mill will be exposed at all to working between a rolling and a stationary stone.

Some modifications in the operation of the invention with the aid of a device constructed according to the novel principles indicated here have already been mentioned above. Further modifications may be resorted to if desired. For example, it is possible to modify the conditions of intermesh between the helical bands according to FIGS. 6A and 6B by shifting both axes towards or away from each other.

If in accordance with the embodiment according to FIGS. 1 to 5 the shafts of the two helical bands are running in mutually opposite directions, the intermeshing band portions in the zone of intermesh will move substantially in the same direction and the working action obtained will be predominantly sliding and substantially uniform with regard to the entire portion caught between the intermeshing band portions. If, on the other hand, in accordance with FIG. 6A the shafts are rotated in the same direction, the intermeshing band portions will move in mutually opposite directions in relation to the material portions caught between them and the motion imparted to the material contained between the intermeshing band sections will be predominantly rolling whereby a more pronounced comminuting or crushing effect is obtained.

The process and device according to the invention are useful not only for working moisture containing fibrous material but equally for treating various other materials in

both dry and moist condition, particularly for mixing comminuting, crushing and conveying various materials.

In accordance with the invention there is provided a machine of great versatility which may be easily modified to suit any specific material treated and any specific treatment performed. In the machine a great variety of treatments may be performed alternatively or simultaneously, one single working treatment in most cases being sufficient in order to obtain a final product which, in addition, may be shaped or filled into containers or packages during or in termination of the treatment. The machine may operate continuously, under recirculation conditions or batchwise.

What I claim is:

1. An apparatus for performing a mixing and structure modifying working treatment of moisture-containing cellulosic material, said apparatus comprising a housing having inlet and outlet openings, two shafts journaled in said housing and adapted to be synchronously driven in mutually opposite directions, a left-handed helical band extending about one of said shafts and a right-handed helical band extending about the other shaft, the spacing between each point on the circumference of one of said helical bands and the surface of the corresponding shaft being greater than the minimum spacing between the same point and the surface of the shaft of the other helical band, said helical bands thus extending into each other's bodies of revolution, the pitch of the helical winding of said bands, and the radial width thereof being such that a predetermined spacing is maintained, and a single zone of mutual overlap is formed, between such portions on different bands which mutually extend into each other's bodies of revolution, the edge of each helical band which is closest to the surface of the respective shaft being radially spaced from the surface of such respective shaft whereby a substantially free return flow space is formed radially inwardly of each of said helical bands.

2. An apparatus for performing a mixing and structure modifying working treatment of moisture-containing cellulosic material, said apparatus comprising a housing having inlet and outlet openings; two shafts journaled in said housing and adapted to be synchronously driven in the same direction; helical bands each extending about one of said shafts in the same direction of helical turn, the spacing between each point on the circumference of one of said helical bands and the surface of the corresponding shaft being greater than the minimum spacing between the same point and the surface of the shaft of the other helical band, said helical bands thus extending into each other's bodies of revolutions; the pitch of the helical winding of said bands, and the radial width thereof, being such that a predetermined minimum spacing is maintained, and only a single zone of mutual overlap is formed, between such portions on different bands which mutually extend into each other's bodies of revolution; the edge of each helical band which is closest to the surface of the respective shaft being radially spaced from the surface of such respective shaft whereby a substantially free return flow space is formed radially inwardly of each of said helical bands.

3. Mixing and treating apparatus comprising a housing having inlet and outlet openings, synchronously driven shafts in the said housing; mutually intermeshing, radially directed helical bands on each of said shafts; said helical bands having a pitch such that a predetermined minimum

spacing is maintained, and a radial width such that only a single zone of mutual overlap is formed, between intermeshing portions on different bands; said helical bands being supported with their radially inner edges radially spaced from the peripheral surfaces of the respective shafts to define substantially uninterrupted annular passages extending longitudinally of the respective shafts.

4. The apparatus as claimed in claim 3, in which the helical bands are wedge-shaped in cross section converging towards the outer periphery.

5. The apparatus as claimed in claim 3, in which the cross-sectional shape of the helical bands varies in continuous transition from quadrilateral shape, having parallel opposed side surfaces, at the inlet, to a radially outwardly converging wedge form towards the outlet.

6. The apparatus as claimed in claim 3 in which the radial width of the helical bands increases from the inlet to the outlet.

7. The apparatus as claimed in claim 3 in which the surfaces of said bands are grooved.

8. The apparatus as claimed in claim 3, comprising material comminuting members rotatable coaxially with the helical bands.

9. Apparatus for treatment of liquid suspended cellulosic material comprising a housing having inlet and outlet openings; a pair of helical bands each having its longer lateral dimension directed substantially radially of its helix axis; means rotatively supporting said helical bands in mutually intermeshing relation in said housing; and means for synchronously rotating said intermeshing helical bands in said housing; said helical bands having a pitch such that a predetermined minimum spacing between the surfaces of intermeshing helical band portions is maintained during synchronous rotation of said bands; the radially inner edges of said helical bands during rotation defining a straight central flow passage for the treated material; said helical bands having a radial width such that only a single zone of mutual overlap is formed between intermeshing helical portions.

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