Feb. 5, 1946. J. INGLIS 2,394,182

PAPER STOCK DISINTEGRATOR

Filed Nov. 18, 1942 3 Sheets-Sheet 1

Fig. 1.

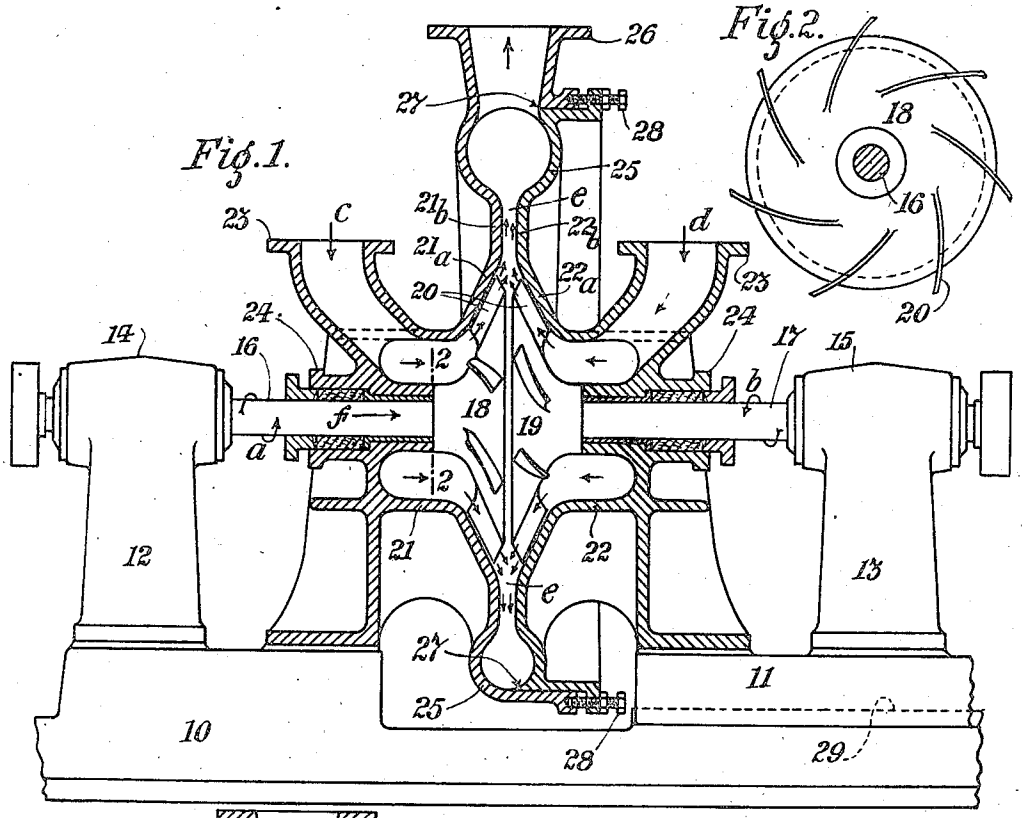


Fig. 2.

Fig. 5.

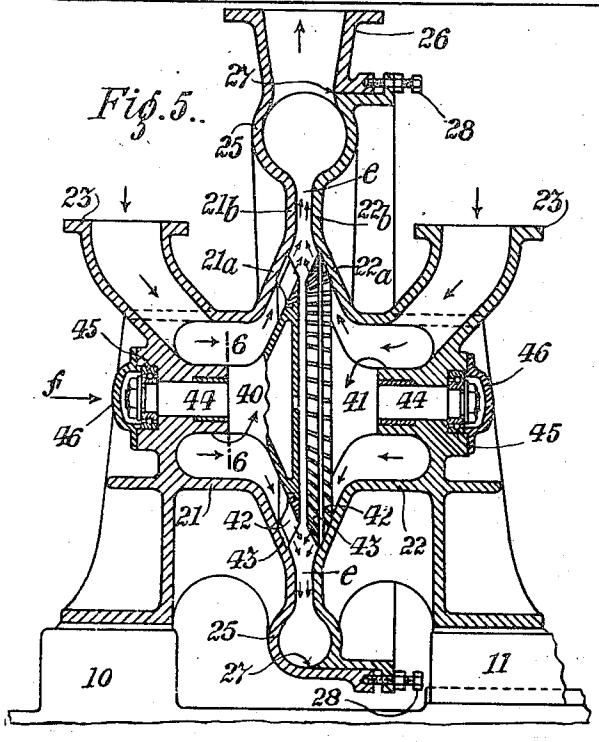
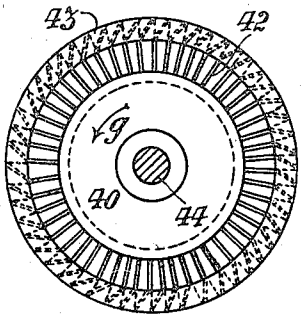


Fig. 6.



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PAPER STOCK DISINTEGRATOR

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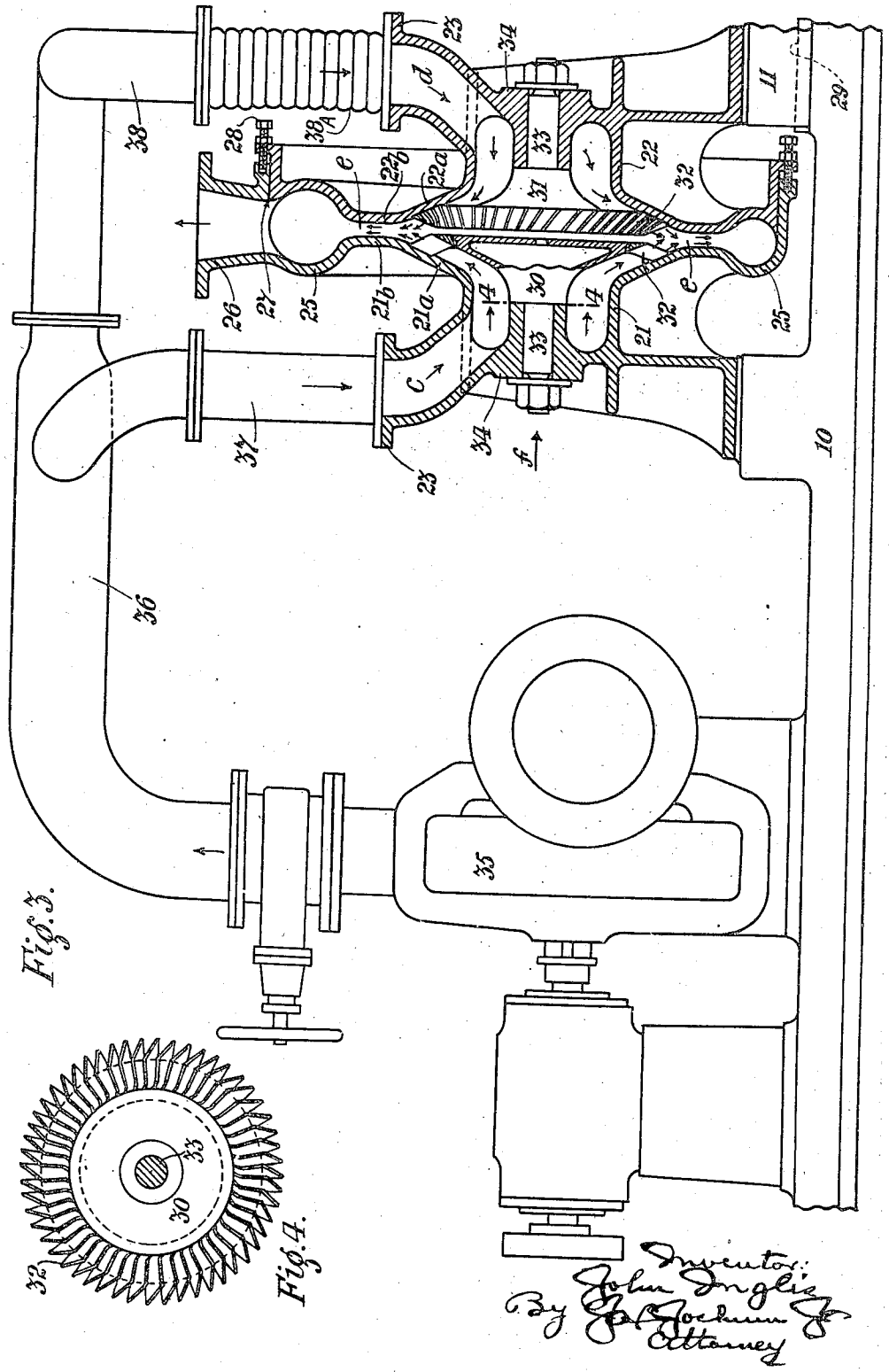


Fig. 3.

Fig. 4.

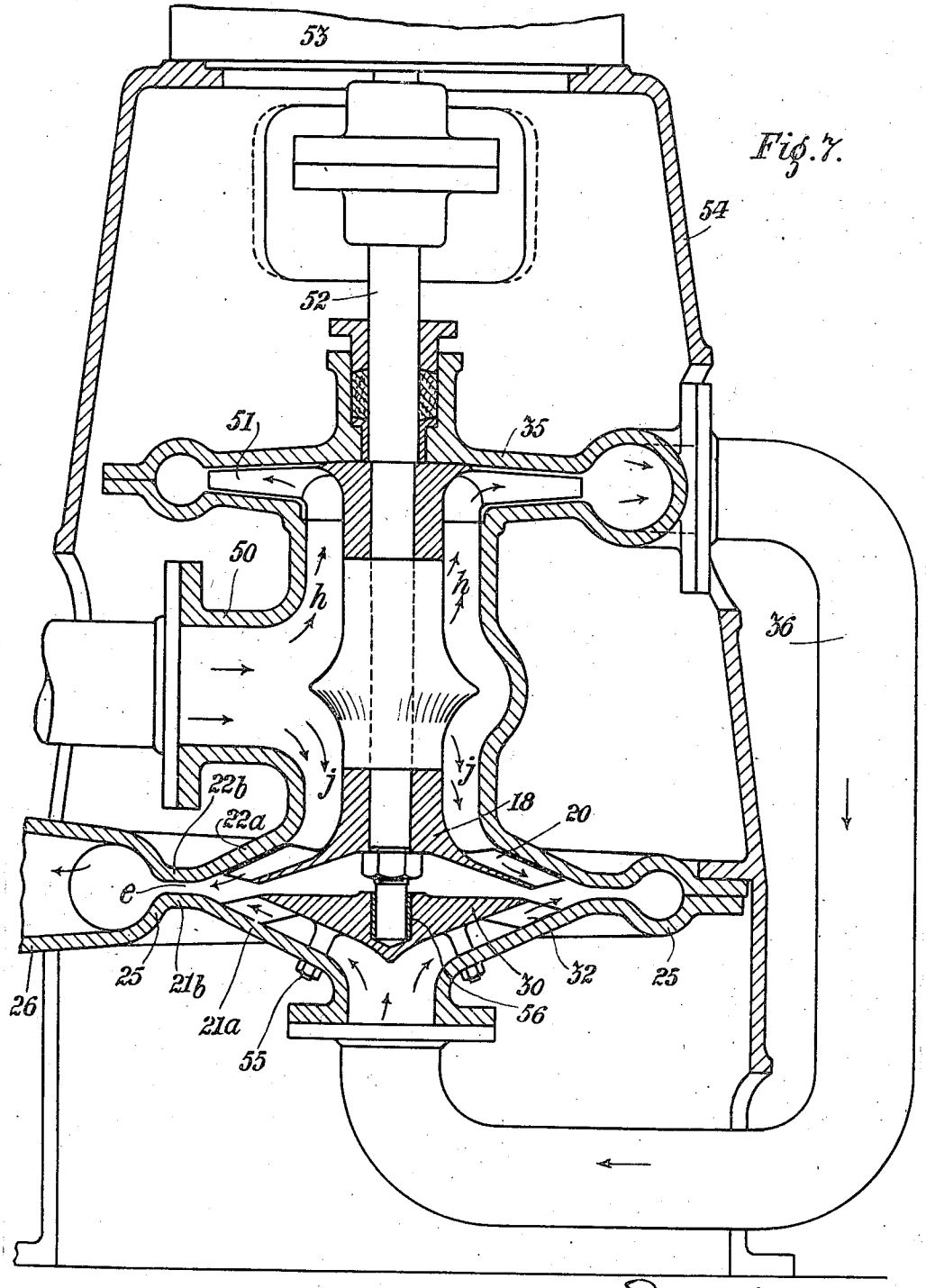
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PAPER STOCK DISINTEGRATOR

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Fig. 7.



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PAPER STOCK DISINTEGRATOR

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Application November 18, 1942, Serial No. 466,006
In Great Britain November 20, 1941

14 Claims. (Cl. 92—26)

This invention relates to the treatment of matted fibrous material in the manufacture of paper, paper board and the like (hereinafter called "paper"), in which the fibrous material in liquid suspension (hereinafter and in the appended claims called "paper stock") is acted upon in such a manner that the fibrous material is disintegrated; that is to say, the fibres are separated from one another, without loss of their physical properties, to prepare them for subsequent manufacture into paper. Such treatment is commonly (also hereinafter and in the appended claims) called "disintegrating," and is commonly employed, for example, in such processes as refining and blending woodpulp, fibrous material produced from boiled esparto grass or straw, and pulped waste paper. The expression "matted fibrous material" is meant to cover any of the various materials used in liquid suspension in the manufacture of paper of which the fibres are matted, or clumped, or clustered, together naturally or mechanically.

An object of this invention is to provide an improved method of and means for disintegrating the matted fibrous material whereby it is assured that the effective action will consist mainly or practically only of rubbing between the suspended particles of fibrous material in the paper stock as distinguished from rubbing between them and the metal parts of mechanical beating, breaking or like means.

Another object of the invention is to provide a method of disintegrating (as hereinbefore defined) which comprises supplying paper stock in separate flows and forcing the respective flows to advance into one another at high speed as oppositely rotating vortices, thereby causing the fibrous materials of each of these vortices to rub intimately against the differently directed materials of the other vortex.

Another object of the invention is to provide a method as aforesaid in which the vortices of paper stock have the form of coaxial hollow circular sheets, or more specifically hollow frusto-cones, the bases of which merge into one another in an annular zone where the main disintegrating action occurs.

Another object of the invention is to provide a machine for disintegrating (as hereinbefore defined) which machine is characterised by vortex generators inside a casing for forming separate flows of paper stock into the form of vortices which advance into one another at high speed, rotating in opposite directions as they advance.

Other objects of the invention will be apparent from the following description with reference to the accompanying drawings, which are somewhat diagrammatic and in which:

Fig. 1 is a sectional elevation of a machine for disintegrating paper stock embodying the invention; and Fig. 2 is an axial view of one of two vaned rotors shown in Fig. 1, the view being a section on line 2—2 of Fig. 1.

Fig. 3 is a view corresponding to Fig. 1 but illustrative of another embodiment of the invention involving the use of stationary vaned structures instead of rotors; and Fig. 4 is a view of a vaned stator, being a section on line 4—4 of Fig. 3.

Fig. 5 is also a view corresponding to Fig. 1 but illustrative of yet another embodiment of the invention. Fig. 6 is a view of a vaned rotor, being a section on line 6—6 of Fig. 5.

Fig. 7 is a sectional elevation of yet another embodiment of the invention.

Throughout the drawings, parts which are similar to one another are denoted by the same reference numerals.

Referring to Fig. 1, the machine therein illustrated comprises a main base 10, an auxiliary base 11 thereon and two pedestals 12, 13 on said bases. The pedestals 12, 13 support bearings 14, 15 in which are journalled two external-power-driven shafts 16, 17. These shafts are rotated in mutually opposite directions, as indicated by the arrows *a*, *b*. The external power drive of these shafts may be derived from electric motors (not shown) and such motors may be direct-coupled to the shafts, in which event the motors may be mounted respectively on the bases 10 and 11.

The machine includes mainly a vaned assembly for propelling separate flows (indicated by arrows *c*, *d*) of paper stock towards one another and for rotating them in mutually opposite directions. Said assembly comprises two coaxial rotors (or impellers) 18, 19, which are respectively secured to the shafts 16 and 17 and which have similarly vaned frusto-conical surfaces whose bases face one another. The vanes are denoted by 20 (see also Fig. 2). The rotors are arranged in a two-part casing 21, 22 which at opposite ends has inlet branches 23 for the two flows *c*, *d* of paper stock and glands 24 close to the bearings 14, 15 for the driving shafts 16, 17 of the rotors. The casing has coned portions 21*a*, 22*a* presenting guide surfaces between which and the vaned surfaces of the rotor conically annular vortex chambers are provided for the paper

stock. The vanes 20 are spirally arranged plates, of which there are a small number on each rotor (seven are shown by way of example) and which project closely to the portions 21*a*, 22*a*. The spirals of the vanes on both rotors are right handed (as Fig. 1 shows). The roots of the vanes are secured to the respective rotor and their tips come close to the guide surface of the respective coned portion 21*a* or 22*a* of the casing. The coned portions, at their conical bases, merge smoothly and continuously into flared skirts forming spaced flat annular walls 21*b*, 22*b* between which is provided a narrowly restricted annular mixing zone *e* into which the surfaces 21*a*, 22*a* lead. The zone *e* opens into an approximately annular discharge chamber 25 expanding towards a radial outlet branch 26.

It will be seen that the rotors 18, 19 are inner members of generally conical shape, that the casing walls 21*a*, 22*a* are outer members also of generally conical shape, and that these inner and outer members co-operate to form the aforesaid vortex chambers, these chambers being divergent annular passages into the smaller ends of which the conduits 21, 22 open and which open at their larger ends into the mixing zone *e*.

In use of such a machine, the paper stock is caused to flow into the casing by way of the inlet branches 23 either under external pressure (for example, the pressure derived from a head of paper stock in a supply system at a higher level than the machine) or under internal suction generated by the vaned rotors. The paper stock follows the paths *c*, *d*, which extend through conduits formed in the casing into the vortex chambers from opposite ends of the casing 21, 22 and is formed by the rotors 18, 19 which are rotated at about equal but mutually opposite speeds, into hollow circular sheets, or more specifically conical vortices. That is to say, the inclined vanes 20 are positively constrained by the power-driven shafts 16, 17 to force the oppositely advancing flows of paper stock against one another as oppositely rotating vortices. Thus, the rotors function as vortex generators. These vortices advance under the external confinement and guidance of the surfaces 21*a*, 22*a* towards one another and are rotated around their respective lines of advance—namely, the axes of the rotors 18 and 19 at progressively increasing speed as they advance in directions which are mutually opposite; that is to say, if the vortices were both viewed in the direction of the arrow *f* in Fig. 1, the vortex formed by the proximal flow *c* would be clockwise, whereas the vortex formed by the distal flow *d* would be counter-clockwise. Finally, the two vortices are propelled at the greatest speed reached into one another as they are about to enter the annular mixing zone *e* and the particles of fibrous material of each vortex brush frictionally against those of the other vortex in a vigorous manner. Thus, the main disintegrating action is effected. The action continues as the material of the two vortices is forced uninterruptedly outwards under the smooth and continuous guidance of the walls 21*a*, 22*a*, and 21*b*, 22*b* through the restricted mixing zone *e* into the discharge chamber 25.

As the particles of material when in the vortices are dispersed throughout comparatively thin liquid streams of large surface area, effective disintegration of the entire mass is assured when the vortices merge into one another. The fibrous materials of the two vortices finally intermingle and combine in the restricted mixing zone *e*, which is radially long enough for the purpose. The now combined supplies of paper stock pass into the discharge chamber 25 and pass therefrom by way of the outlet branch 26 in a single flow.

The degree of disintegration of the fibrous material is dependent upon factors which include the width of the gap between the two rotors 18, 19 and of the space between the coned portions 21*a* and 22*a* enclosing the vortex chambers and between the flared skirts 21*b* and 22*b* defining the mixing zone *e*. It is desirable that provision should be made to enable the operating personnel to regulate the degree of disintegration. Therefore in the machine illustrated means are provided for varying the width of said gaps and space. As shown, the two main parts comprising the casing 21, 22 are adjustable to-and-from one another by providing between them a cylindrical joint at 27 and regulating screws 28. Moreover, to permit adjustment by said screws 28 of the casing part 22, rotor 19 and associated parts, the auxiliary base 11 carrying said parts has a slide mounting at 29 on the main base 10.

According to the modification illustrated by Figs. 3 and 4, the vaned assembly is a stationary structure, the general form of which and of the casing containing it are similar to those described with reference to Figs. 1 and 2. In this modification there are provided instead of vaned rotors two corresponding arranged vaned stators 30, 31. Each of these stators has a multiplicity of narrow inclined vanes 32, which in the example shown (see Fig. 4) have a right-hand inclination and the tips of which bear hard against the inner surfaces of the coned portions 21*a*, 22*a* of the casing. The stators 30, 31 are respectively secured to shafts 33 which are rigidly secured to bosses 34 in the casing 21, 22.

Paper stock to be disintegrated in the machine is led to it at a rate sufficient to ensure that the paper stock will be formed by the stationarily constrained vanes of the respective stators into vortices which will advance into one another as they rotate in mutually opposite directions, as in the embodiment according to Figs. 1 and 2. In the example illustrated by Fig. 3, the requisite rate of flow of the paper stock supplied is obtained by use of a motor-driven centrifugal pump 35. The delivery branch of this pump is coupled to a supply pipe 36 which leads into branch pipes 37, 38 respectively coupled to the inlet branches 23 of the machine. Pipe 38 is partly flexible, at 38A.

According to the modification illustrated by Figs. 5 and 6, vaned rotors 40, 41 are driven not by coupling their shafts to power drives but in the manner of turbines by the incoming flows of paper stock under pressure. Each of said rotors is provided with a multiplicity of vanes 42, which in the example (see Fig. 6) have a right-hand inclination and the roots of which are secured to the rotor and the tips of which are secured to an outer ring or shroud 43. Each ring 43 rotates closely to the inner surface of the respective coned portion 21*a* or 22*a* of the casing 21, 22. The rotors are secured to shafts 44 which are journalled in bearings 45 provided in bosses in the casing and closed by caps 46.

The paper stock to be disintegrated must be supplied at a rate sufficient to set the rotors in rotation and to ensure generation thereby of the requisite vortices, which must rotate in mutually opposite directions and advance into one another as in the previously described embodiments.

Therefore, paper stock may be supplied to the inlet branches 23 in the same manner as described with reference to Fig. 3.

In the embodiment according to Figs. 5 and 6, as in that according to Figs. 1 and 2, the vortex set up by the proximal rotor when viewed in the direction of the arrow *f* will be clockwise. However, the proximal rotor in the present example—that is, the rotor 40 according to Figs. 5 and 6—will rotate in the counter-clockwise direction as indicated by arrow *g* due to the reaction against which the vortex is generated.

In the embodients according to Figs. 1 and 2, the tips of the rotor vanes come close to the inner surface of the respective coned portion 21*a* or 22*a* of the casing. Instead however the vane tips may be secured to a surrounding ring or shroud as in the modification according to Figs. 5 and 6, in which event the surrounding ring would come close to said inner surface.

In each of the embodiments hereinbefore described the vaned members are a true pair; that is, each vaned member, be it a rotor or a stator, co-operates with a similar member, and if said members are rotors they both derive their rotation from the same source. Such pairing of these members is not necessary although in practice it will generally be adopted for simplicity of construction and for general balance in the operation of the machine. Moreover, in each of said embodiments, the vortices are generated to rotate about a common horizontal axis; and this arrangement also is not necessary. By way of example, Fig. 7 is given to illustrate that the vaned members need not be paired and need not work about a horizontal axis.

Referring to Fig. 7, in the modification therein shown a motor-driven vaned rotor 18 co-operates with a vaned stator 30 and both generate vortices which rotate about a common vertical axis in casing portions 21*a*, 22*a*, and 21*b*, 22*b*. As in the previous embodiment these portions enclose vortex chambers which open into a restricted mixing zone *e* delivering the disintegrated paper stock to a discharge chamber 25 with an outlet branch 26. The machine has a single inlet branch 50 from which the paper stock divides in two flows *j* and *h*. The flow *j* passes direct to the motor-driven rotor 18 which has vanes 20 and functions similarly to either of the rotors in the embodiment according to Figs. 1 and 2. The flow *h* passes firstly to a centrifugal pump 35 the vanes 51 of which propel the paper stock through the supply pipe 36 to another inlet branch leading to the stator 30. The vanes 32 of the stator function as in the embodiment according to Figs. 3 and 4. The vaned rotor 18 is secured to a vertical shaft 52 driven by an electric motor 53 which is supported by a frame 54 enclosing the machine. The vaned stator 30 is bolted as at 55 to the casing and forms a footstep bearing as at 56 for the rotor shaft 52.

In each of the foregoing embodiments, each vortex is formed around an externally vaned member which more or less fills the cavity of the vortex. Instead, the vaned assembly may comprise opposed coaxial rotors into which separate flows of paper stock are supplied and which are internally vaned, the arrangement being such that in the rotation of the rotors the stock therein forms under centrifugal force into axially advancing vortices which lie against the interior walls of the rotors.

As the machine, according to any of the embodiments hereinbefore described, can be incorporated in a closed paper stock system, the pressure head at the outlet branch 26 can be utilised to force the disintegrated paper stock through piping or other conduits as required.

The paper stock, previous to use in the machine, may be heated or hydrated or chemically treated, or may be subjected to any two or more of these treatments, in order to facilitate the disintegrating process and/or the removal from the fibres of any particles of clay, ink and other matter which may be adhering to them.

The consistency of the paper stock may be varied within wide limits depending on the nature of the material used and the result required.

The invention is also applicable to a process of blending two different paper stocks by supplying one of such paper stocks to one of the vortices and supplying the other of such paper stocks separately to the other of the vortices.

I claim:

1. A paper stock disintegrating machine comprising a casing, flat spaced walls in said casing forming between them an annular disintegration chamber, two conduits in said casing for leading supplies of paper stock to said chamber, a pair of coaxial rotors arranged end to end in said conduits respectively, external-power-driven coaxial shafts to which said rotors are respectively secured, said shafts and the rotor thereon being rotatable in opposite directions, inclined vanes on said rotors serving the double purpose of advancing said supplies into one another and rotating them in mutually opposite directions as they advance so that said rotors deliver said supplies as oppositely rotating vortices to said chamber, and an outlet in said casing for discharging said supplies in an intermingled and disintegrated state from said chamber.

2. A paper stock disintegrating machine comprising a casing, two inlets therein for separate flows of paper stock, two rotors forming with said casing opposed annular vortex chambers which extend towards one another from said inlets, an annular mixing chamber in said casing into which said vortex chambers open, sets of vanes on said rotors in the respective vortex chambers, the set of vanes on one rotor inclining to the same hand as those on the other rotor, external-power-driven coaxial shafts to which said rotors are respectively secured and which rotate said rotors in opposite directions, said rotors forming said flows of paper stock in said vortex chambers into oppositely rotating vortices advancing into one another and said sets of vanes driving said flows rotationally into one another in opposite directions so that said flows intermingle in said mixing chamber, and an outlet in said casing to lead from said mixing chamber disintegrated paper stock produced therein by the intermingled flows.

3. A paper stock disintegrating machine as claimed in claim 2 comprising also a chamber which encircles the casing to collect therefrom the disinterated paper stock and deliver same to said outlet.

4. A paper stock disintegrating machine comprising a casing consisting mainly of two frusto-conical walls arranged coaxially base to base to enclose opposed vortex chambers, two flat annular walls spaced narrowly apart to enclose between them a disintegration chamber, said frusto-conical walls expanding smoothly into said flat walls so that said vortex chambers both open at their larger ends into said disintegration chamber, and two inlets for leading separate flows of paper stock into said vortex chambers at their smaller

ends, frusto-conical rotors located coaxially inside said frusto-conical walls respectively and rotated under external power in opposite directions, and vanes on said rotors projecting to the respective said frusto-conical walls and extending closely to said disintegration chamber, said vanes on the respective rotors being inclined to the same hand to propel said flows through said vortex chambers and through said disintegration chamber continuously and unobstructedly and also to rotate said flows in said vortex chambers and drive them rotationally oppositely into one another in said disintegration chamber to intermingle therein and disintegrate their particles.

5. A paper stock disintegrating machine comprising a casing consisting mainly of two frusto-conical walls arranged coaxially base to base to enclose opposed vortex chambers, two flat annular walls spaced narrowly apart to enclose between them a disintegration chamber, said frusto-conical walls expanding smoothly into said flat walls so that said vortex chambers both open at their larger ends into said disintegration chamber, and two inlets for leading separate flows of paper stock into said vortex chambers at their smaller ends, frusto-conical bodies located coaxially inside said frusto-conical walls respectively and vanes located in he vortex chambers between the respective said frusto-conical walls and bodies, said vanes being close to said disintegration chamber and the vanes of the respective chambers being inclined to the same hand to rotate said flows, whilst under the external and internal guidance of said frusto-conical walls and bodies respectively, oppositely into one another in said disintegration chamber so as to intermingle therein and disintegrate their particles.

6. A paper stock disintegrating machine comprising a casing, inner members of generally conical shape in said casing, said casing having closely spaced walls that provide an annular disintegration chamber and also having walls of generally conical shape constituting outer members that cooperate with said inner members to form divergent annular passages opening at their larger ends into said chamber, conduits at opposite ends of said casing for leading supplies of paper stock in opposite directions to said passages and chamber, said conduits opening into the smaller ends of said annular passages, sets of vanes mounted at an inclination on selected ones of said inner and outer members, there being one set of said vanes to each selected member and the vanes of the different sets being inclined to the same hand and located in said annular passages, said vanes by virtue of their mountings on the selected members being constrained in relation to the paper stock for co-operation with said annular passages to transform said supplies into relatively oppositely rotating hollow circular sheets of paper stock and being extended to said chamber to force said sheets rotationally oppositely into one another therein, and an outlet in said casing for discharging said supplies in an intermingled and disintegrated state from said chamber.

7. A paper stock disintegrating machine as defined in claim 6 in which said inner members of generally conical shape are coaxial structures presenting frusto-conical surfaces arranged base-to-base and in which said sets of inclined vanes are mounted on said surfaces respectively.

8. A paper stock disintegrating machine as defined by claim 6 wherein said inner members of generally conical shape include at least one structure on which one of said sets of vanes is mounted and which is constrained in relation to the paper stock flowing through the respective divergent annular passage by being fixed in said casing.

9. A paper stock disintegrating machine as defined by claim 6 wherein said inner members of generally conical shape include at least one freely rotatable rotor on which one of said sets of vanes is mounted and which is journalled in said casing to work under reaction against paper stock flowing through the corresponding one of said divergent annular passages.

10. A paper stock disintegrating machine as defined by claim 6 wherein said inner members of generally conical shape include at least one external-power-driven rotor journalled in said casing, on which rotor one of said sets of vanes is mounted.

11. A paper stock disintegrating machine comprising a casing, inner members in said casing, said casing having closely spaced walls that provide an annular disintegration chamber and also having walls constituting outer members that are in closely spaced relationship and co-operate with said inner members to form annular passages opening into said chamber, conduits at opposite ends of said casing for leading supplies of paper stock in opposite directions to said passages and chamber, said conduits opening into said annular passages, sets of vanes mounted at an inclination on selected ones of said inner and outer members, there being one set of said vanes to each selected member and the vanes of the different sets being inclined to the same hand and located in said annular passages, said vanes by virtue of their mountings on the selected members being constrained in relation to the paper stock for co-operation with said annular passages to transform said supplies into relatively oppositely rotating hollow circular sheets of paper stock and being extended to said chamber to force said sheets rotationally oppositely into one another therein, and an outlet in said casing for discharging said supplies in an intermingled and disintegrated state from said chamber.

12. A paper stock disintegrating machine as defined by claim 11 wherein said inner members include at least one structure on which one of said sets of vanes is mounted and which is constrained in relation to the paper stock flowing through the respective annular passage by being fixed in said casing.

13. A paper stock disintegrating machine as defined by claim 11 wherein said inner members include at least one freely rotatable rotor on which one of said sets of vanes is mounted and which is journalled in said casing to work under reaction against paper stock flowing through the corresponding one of said annular passages.

14. A paper stock disintegrating machine as defined by claim 11 wherein said inner members include at least one external-power-driven rotor journalled in said casing, on which rotor one of said sets of vanes is mounted.

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