Dec. 28, 1954 H. D. HYMAN 2,697,966

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Filed Oct. 22, 1951 3 Sheets-Sheet 1

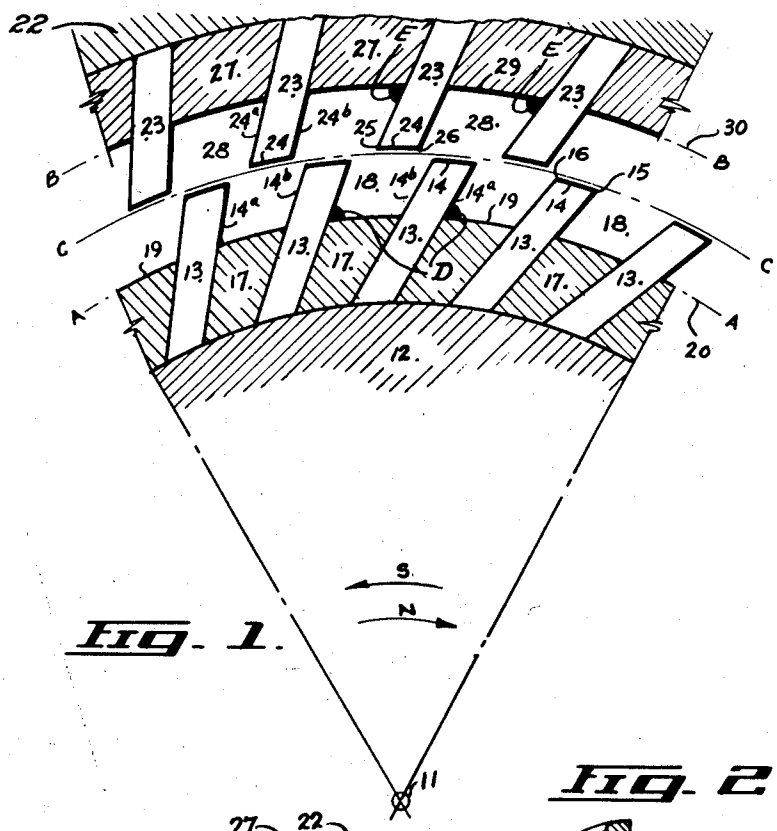
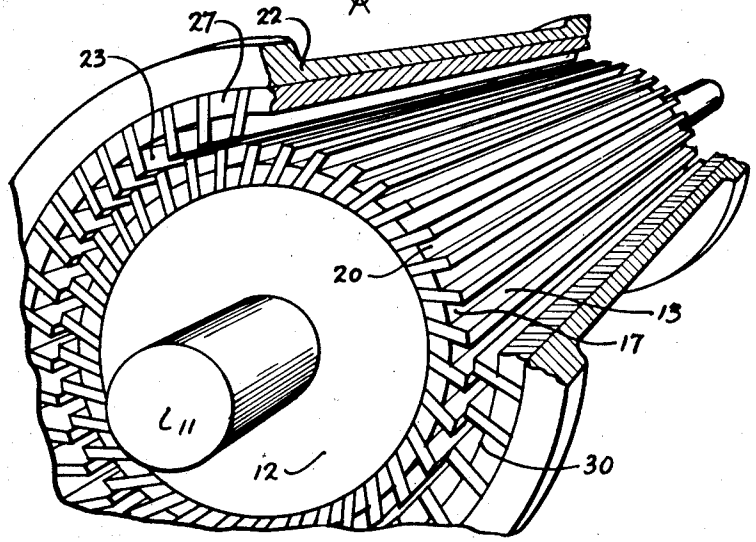


Fig. 1.

Fig. 2.



INVENTOR

HOWARD D. HYMAN

BY Bailey, Stephens & Huettig

ATTORNEYS

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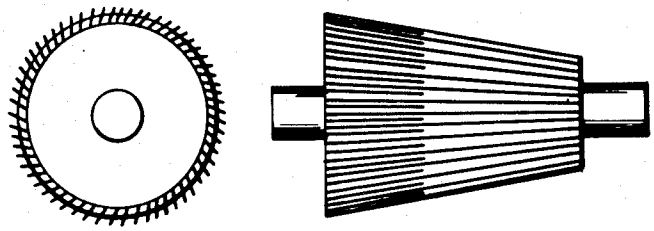


Fig. 3a.

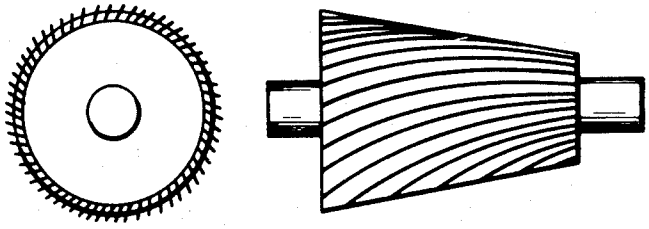


Fig. 3b.

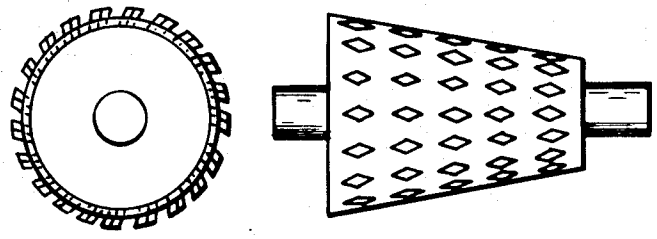


Fig. 3c.

INVENTOR

HOWARD D. HYMAN

BY Bailey, Stephens & Huettig

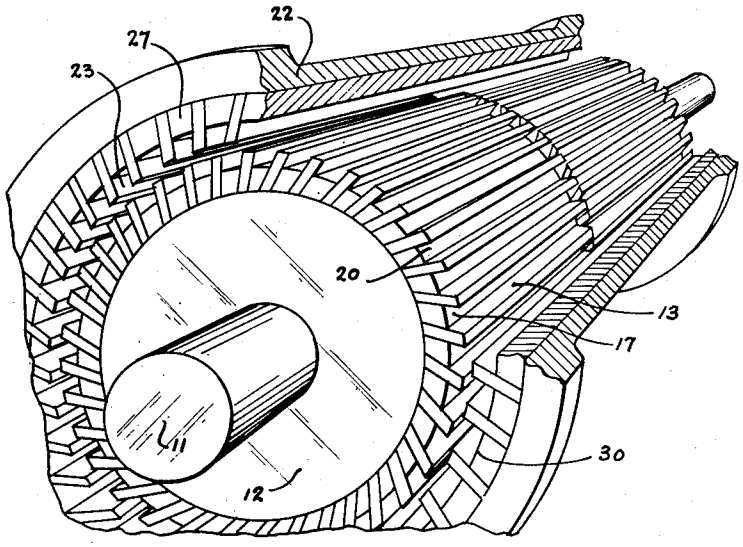
ATTORNEYS

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Fig. 4.



INVENTOR
HOWARD D. HYMAN
BY Bailey, Stephens & Hulbig
ATTORNEYS

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PAPER REFINER

Howard Davison Hyman, Ottawa, Ontario, Canada, assignor to The Alexander Fleck Limited, Ottawa, Ontario, Canada, a corporation

Application October 22, 1951, Serial No. 252,473

Claims priority, application Canada October 26, 1950

4 Claims. (Cl. 92—22)

This invention has to do with improvements in machines for refining paper stock and similar mixtures composed of liquids and fibres, and in particular with those conical or cylindrical or similar machines which rotate, gyrate or reciprocate and as such are used either for cutting, tearing, brushing, crushing, flexing, rolling or splitting the fibres or for combinations of the above treatments.

Machines for performing the operations mentioned above are normally referred to as beaters, beater engines, Jordans, Jordan engines, refiners, refining presses, pulpers, crushers, attrition mills etc.

The operation known as cutting is performed by severing the fibre transversely with respect to its length to shorten it, while the operation known as brushing is performed by forcing the fibre to move past moving surfaces which surfaces tend to split, rub, flatten, roughen the surface by rubbing past it.

The principle underlying both the machines used for cutting (Jordans for instance) and machines used for brushing (refiners for instance) is that the fibres are worked between a set of projections or blades, projecting from the surface of the plug of a Jordan or refiner which are moving relative to a set of projections or blades, projecting from the surface of the shell of the Jordan or refiner respectively.

The terms conical and cylindrical are not meant to be limiting for the operations since any shape which may be defined as a solid of revolution is useable for the exterior surface of the plug and the interior surface of the shell, while the terms plug and shell are not limiting but are the names for the parts of the Jordan and refiner which are used as examples. If for example a beater were described the terms roll and bedplate would be used instead of plug and shell and similarly the appropriate terms of the art could be used for any of the machines listed in paragraph 2 without affecting the subject matter of this disclosure.

The action of cutting is one of scissoring between the edges of the relatively moving blades or projections while the action of brushing is one of stroking between the faces of the relatively moving blades or projections.

In a Jordan the blades or projection of the plug and shell are made to move past one another in sliding contact in order to effectively scissor the fibres but it is to be understood that although the large proportion of the fibres will be scissored in a Jordan, some of them may be stroked as is meant to be performed in a machine such as a refiner. Furthermore some proportion of the fibres may not be either cut nor brushed but may receive forms of treatment which are intermediate between cutting and brushing and these forms are known in the art as crushing, tearing, flexing, rolling, or splitting the terms being descriptive of the effect of the operation on the fibres.

In a refiner the blades or projections of the plug and shell are made to move past one another with a certain tolerance between the relatively moving blades, in order that the fibres may be brushed but it is to be understood that although the large proportion of the fibres will be brushed in a refiner, some of them may be cut as is meant to be performed in a machine such as a Jordan. Furthermore, some proportion of the fibres are neither brushed nor cut but receive the intermediate forms of treatment recited in the preceding paragraph.

Thus a Jordan is, for the purposes of this disclosure, chosen as an example of a machine in which a large proportion of the fibres are cut, and which is designed for this purpose, while a refiner is chosen for the purposes

of this disclosure, chosen as an example of a machine in which a large proportion of the fibres are brushed and which is designed for this purpose. This invention as it applies to Jordans and cutting is applicable to the other machines recited in paragraph 2 in proportion to the amount of cutting or similar intermediate operations which they perform and this invention as it applies to refiners and brushing is applicable to the other machines recited in paragraph 2, in proportion to the amount of brushing or similar intermediate operations which they perform.

In the machines at present used for cutting, and those used for brushing the sides of the blades or projections are substantially perpendicular to the surface (hereafter called the mounting surface) of the plug, shell or similar member from which they project. While the cutting, brushing and other operations have been done in a satisfactory way by machines using the blade design described above, it is an object of this invention to improve the efficiency, that is the amount of work done on the stock for the amount of power consumed, for both types of machine, by altering the angle between the sides of the blades or projections and the mounting surface when viewed in a cross-section taken through the plug and shell or respective similar members, the cross-section being perpendicular to the axis of symmetry of the members.

Although the sides of the blades or projections are now substantially perpendicular to the mounting surface of the plug or shell, and the end faces are substantially parallel to the mounting surface, the shapes of the blades or projections when viewed in a plane tangential to the mounting surface is subject to many variations, and may be quite different on the plug and the shell. The blades or projections, may for example be knife-like, stubby, cylindrical, diamond-like, crescent-like or curved. This invention is applicable to all such shapes and to others which are now used for the same purposes.

Furthermore, the invention applies to actual blades or bars interspersed with, and projecting from filler material (such as wood) which forms the mounting surface in this case, or to projections assembled on a surface or backing, the space between them sometimes being filled with wood or other materials, or projections produced by grooving or drilling of a solid piece of material, or cast to a design or deposited by electroplating. The material from which they are constructed may be ferrous or non-ferrous metal, basalt lava, and the like, Carborundum and the like or any material from which the working parts might be made.

For simplicity, the projections and blades will hereafter be designated as blades, regardless of their shape when viewed in a plane tangential to the mounting surface, and the surface from which they project will be referred to as the mounting surface regardless of whether the blades (or projections) and the surface, are the same or separate members.

Other objects and advantages of this invention will appear hereinafter.

The invention is demonstrated in the accompanying drawings.

Figure 1 is a cross-section taken perpendicular to the axis symmetry of a Jordan, or refiner shell and plug.

Figure 2 is a partial assembly of a Jordan plug and shell.

Figures 3*a*, 3*b* and 3*c* show three types of blade shape viewed in plane tangential to the mounting surface of a plug and are not limiting but are intended to be representative of the many blade designs to which the invention applies.

Figure 4 illustrates the embodiments of this invention, in which there are two sets of oppositely angled blades.

In machines of the type referred to, where stock is worked between two members having projecting blades, the only restriction on the rates of rotation of the two members is that they rotate at different angular velocity. Thus one member may be stationary while the other rotates, the members may rotate in opposite directions, or they may both rotate in the same direction at different angular velocities. Since the commonest case is when the inner member (for example the plug) rotates, and the outer member (for example the shell) is stationary, this

case is used in the detailed description to follow, the two members being called respectively the stator and the rotor, although it will be seen that the invention applies equally well to the other cases of relative rotation referred to above.

The stock in the example, therefore, is worked between a stator and a rotor, and the stock although subject to deviations of flow direction due to the projections on stator and rotor, flows in a general circumferential direction between stator and rotor at a peripheral speed which varies from point to point in the stock, but which is less than the peripheral speed of the rotor blade tips. Therefore it may be said that relative to the stationary member, the stock flows circumferentially in the direction of movement of the moving member, while relative to the moving member, the stock flows circumferentially in an opposite direction to the direction of movement of the moving member.

The purpose of a refiner is to brush the fibres, and this brushing is performed by rubbing the fibres between the flat end working faces of the blades of the rotor and stator. The rapidity with which the brushing is performed and therefore the efficiency of the machines, depends upon the number of fibres which flow into the intermediary space between the end faces of the stator and rotor blades, per revolution of the rotor.

On contemporary refiners, the blade sides are substantially perpendicular to the mounting surface and the stock is therefore contained in substantially rectangular walls between successive blades of either stator or rotor. Therefore in order to flow between the end faces of the blades, the stock must first flow along a path approximately perpendicular to the general direction of flow. The flow of the stock along such a path is slower than it would be along a path making an acute angle with the general direction of flow.

Furthermore on contemporary refiners the end faces of the blades and the general direction of flow are parallel to the mounting surface and since the blade sides are perpendicular to the mounting surface the stock on travelling out of the well into the intermediary space between stator and rotor blades, must alter its direction of flow by approximately 90°. The flow of stock along such a path is more difficult than it would be, if it were only necessary that the stock alter its direction of flow, by an acute angle.

In order to facilitate the flow of stock, this invention, as applied to a refiner has the blades of both stator and rotor sloped away from the direction of the approaching blades of the alternate member, but keeps the end faces of the blades parallel to the mounting surface and the general direction of flow, so that the leading edge of an approaching blade is obtuse. In this way the direction of stock flow out of the well makes an acute angle with the general direction of flow, and on turning into the intermediary space between the blade end faces, must only alter its direction of flow by an acute angle. The flow of stock being thus facilitated and increased, the number of fibres rubbed between the end faces of the blades per revolution, and consequently the efficiency, is increased.

The purpose of a Jordan is to cut or tear the fibres by scissoring them between edges of the blades of the rotating and stationary members (hereafter called the rotor and stator respectively). In order to be scissored a fibre must be caught on and stapled over the leading edge of an approaching blade of either the stator or the rotor, at the instant a blade of the alternate member passes it. (Although in actual practice sometimes only the rotor moves, the effect on the stock is the same as if the rotor and stator rotated in opposite directions, so for facility of description, the blades of stator and rotor are described as approaching each other.) Thus the number of fibres are cut per revolution of the rotor, and therefore, the efficiency of the machine, is directly proportional to the length of time a fibre, after being caught on the leading corner of a blade, is retained there.

Fibres which have a magnitude of length tend to staple. The length of the stapled ends is seldom equal. If the blade edge over which they are stapled is right angled, or otherwise blunt, the particle will tend to move off the blade edge after a short interval due to the unbalance of the different lengths of the stapled ends, or the unbalance to different viscosity pull from the fluid on the different lengths. However, if the blade edge over which they are stapled is acute angled, the acute angled edge provides friction of greater magnitude than the degree of unbalance, and the particle stays on the blade edge longer, and the chance that it will be scissored by the approaching blade of the opposite member is increased.

On contemporary Jordans the leading edge of the blade has a 90° angle in which one of the arms of the angle is parallel to the direction of motion. This invention by sloping the blades of both the stator and rotor in the direction of the approaching blades of alternate member, but having the outer end faces of the blades substantially parallel to the mounting surface of the blades makes the leading edge of each blade acute. This acute angled edge tends to retain fibres caught on it for a longer time and therefore more fibres are cut or torn on each rotation, and the efficiency of the Jordan is increased.

From the foregoing description it will be seen that the device described can be used for either cutting or brushing. As the blades are constructed with parallel sides, if one edge of the projecting blade is obtuse the other will be acute, therefore, if the machine is rotated in one direction the blade of the stator and rotor will approach each other with the obtuse angle leading and the action of the machine will be one of a refiner. If, however, the machine is rotated in the opposite direction the blades of the stator and rotor will approach each other with the acute angled edge leading and the action will be that of cutting as in a Jordan. It is important to note that the same construction applies to both the refiner and the Jordan and that the same machine can serve a dual purpose with an efficiency in either superior to that of presently employed machines.

A further important feature of this method of construction is that it enables a machine to be constructed that will also enable both operations, i. e. cutting and brushing, to be accomplished simultaneously by the one machine. This is done in the following manner: The blades are mounted on the rotor in two sections. The division between the sections being at right angles to the axis of rotation of the rotor. As an example let us consider a rotor of conical shape rotating in a clockwise direction. At the end of the rotor with the lesser diameter the blades are set with the acute angled edge towards the direction of rotation. The blades at the end of the rotor with the greater diameter are set at an angle with the obtuse angled edge towards the direction of rotation. The division between the two orientations of the projecting blades is, as was mentioned above, at right angles to the axis of rotation and may be situated along the longitudinal axis of the rotor at any spot, the location of the division determining the ratio of brushing action to cutting action.

Referring to the accompanying drawing the invention is described in detail as follows, all parts being equally characteristic of a Jordan, beater or refiner.

11 is the axis of rotation of the rotor **12**, the rotor **12** having blades **13** with end faces **14**, side faces **14***a* and **14***b*, acute edges **15**, obtuse edges **16**, spacers **17** and wells **18**. The outer surfaces **19** of the spacers **17** are on a cylinder or cone represented by circular arc A—A, and the combined outer surface of the spacers form what is known as the mounting surface **20**. The stator **22** has blades **23** with end faces **24**, side faces **24***a* and **24***b*, acute edges **25**, obtuse edges **26**, spacers **27** and wells **28**. The outer surfaces **29** of the spacers **27** are on a cylinder or cone represented by the circular arc B—B, and the combined outer surfaces form what is known as the mounting surface **30**. It is within the scope of this invention to replace separate blades and spacers by a unitary construction which has the same shape, so that blades **13** and spacers **17** may be made as a single element.

The end faces **14** and **24** of the blades **13** and **23** respectively, are almost touching along a cylindrical or conical surface represented by the circular arc C—C.

The cylindrical or conical surfaces represented on the diagram by circular arcs A—A, B—B, and C—C, are either all right cylinders or all right cones and all have their axes coincident with the axis of rotation **11** of the rotor **12**.

The acute angle between the blade side **14***a* and the mounting surface **20** is represented by D. The angle D is for practical purposes: complementary to the obtuse

angle between the blade side **14***b* and the mounting surface **20**, equal to the acute angle of the edge formed by the blade end face **14** and the blade side **14***a* and complementary to the obtuse angle of the edge formed by the blade end face **14** and the blade side **14***b*.

The acute angle between the blade side **24***a* and the mounting surface **30** is represented by E. The angle E is for practical purposes: complementary to the obtuse angle between the blade side **24***b* and the mounting surface **30**, equal to the acute angle of the edge formed by the blade end face **24** and the blade side **24***a* and complementary to the angle of the edge formed by the blade end face **24** and the blade side **24***b*.

It is seen therefore that edge **15** has angle D, edge **16** has angle (180—D), edge **25** has angle E, and edge **26** has angle (180—E).

Angle D may or may not equal angle E, any desired angle may be used, invention residing in the fact that neither D or E is 90°.

The direction of rotation for cutting fibres is indicated by arrow N, while the direction of rotation for brushing fibre is indicated by arrow S.

The body of the stock containing fibres and liquid is contained in the walls **18** and **28**.

For cutting or tearing the rotor is rotated in the direction N and edges **15** and **25** become the leading edges. Fibres caught on either a leading edge **15** or **25** and held there until the alternate leading corner meets the first are then subjected to a scissoring action between the corners **15** and **25** and are then cut or torn and reduced in size.

For brushing the rotor is rotated in the direction S and the edges **16** and **26** become the leading edges. Fibres in the stock flow out of wells **16** or **28** along the side faces **14***b* or **24***b* then along the surface of the end faces **14** or **24** respectively until the alternate end face passes the first and the fibres are then worked between the end faces **14** and **24**.

The same instrument is not usually used for both cutting or tearing and brushing due to the desirability of having both operatings in progress simultaneously, but as far as this invention is concerned, the action is merely decided by the direction of rotation.

Although in the preferred form of this invention, machines having cylindrical or conical rotors, rotating inside stationary members of corresponding shape have been used as examples, the rotor may actually be any solid of rotation, rotating inside a stationary member of corresponding shape. Furthermore the invention fulfills its function equally well if the outer member is rotated and the inner member remains stationary, or if both rotate in either the same or opposite directions.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. A machine for treating fibres contained in a fluid comprising a rotor, a stator coaxial with said rotor, a plurality of spaced parallel sided rotor blades extending from the rotor in the direction of the stator, the parallel sides of each rotor blade forming acute angle with the rotor radius passing through the outer ends of such side, the outer end edges of said blades providing surfaces substantially parallel to the tangent to the radially adjacent portion of the rotor surface, a plurality of spaced parallel sided stator blades extending from the stator in the direction of the rotor and terminating in end edges presenting surfaces parallel to and closely spaced from the end edges of the rotor blades when opposed thereto, said stator blades being sloped in the same direction as the opposed rotor blades, and means for rotating said rotor relatively to said stator.

2. A machine as in claim 1 in which said rotor is adapted to be rotated in the direction towards which the rotor blades are inclined to cause the machine to act as a Jordan and to be rotated in a direction opposite to said direction to cause the machine to act as a refiner.

3. A machine as in claim 1 in which said rotor comprises two sections in axial alignment with each other, the blades mounted on one section being sloped in one direction and the blades mounted on the second section being sloped in a direction opposite to said one direction.

4. A machine for refining fibre comprising a member having an exterior surface which has the surface of a solid of revolution, a second member outside the first member having an interior surface which is a surface of a solid of revolution, means mounting said members for relative rotation therebetween, said members each having a set of blades thereon projecting towards one another, all the blades having acute-angled edges at the same one of the leading and trailing edges and having obtuse-angled edges at the same other of the leading and trailing edges, the faces of each of the blades between such leading and trailing edges being each substantially parallel to the tangents to the portions of the stator and rotor surfaces adjacent such faces, and the longitudinal axes of each of the blades being so inclined at an acute angle with respect to the radius of rotation of the rotor passing through the leading edge of such blade as each to intersect the longitudinal axes of the blades on either side thereof within the body of the rotor.

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