Oct. 23, 1934. T. ROBINSON 1,977,807

METHOD OF DISINTEGRATING

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Fig. 1.

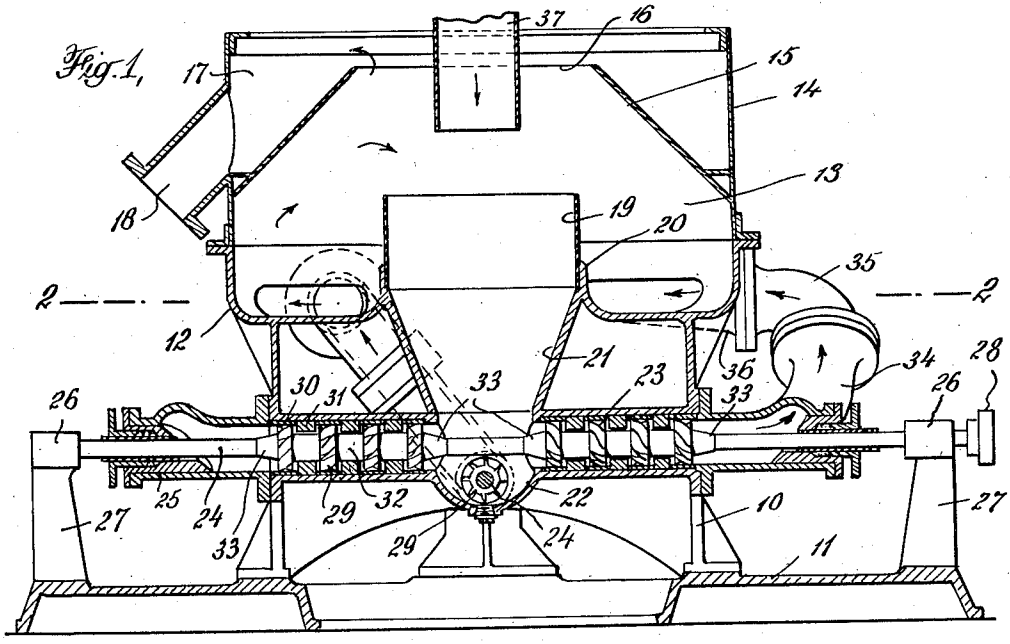
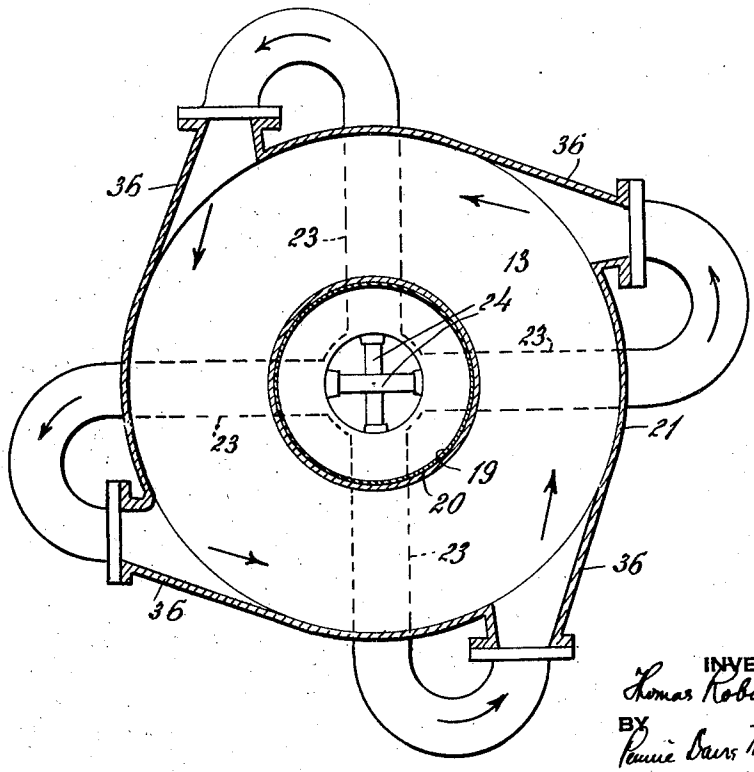


Fig. 2.



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METHOD OF DISINTEGRATING

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14 Claims. (Cl. 92—20)

This invention relates to disintegration of fibrous materials for the purpose of reducing them to a pulp suitable for use in making paper, paper board, and various other products. More particularly, the invention is concerned with a novel method of breaking down fibrous materials to free the fibres, which may be carried on as a continuous operation and without interruption, fresh stock being continuously added to, the supply undergoing treatment and pulp of substantially uniform characteristics being continually withdrawn therefrom during the practice of the method.

The method of my invention is especially suited for the treatment of paper stock and the application of the method to the pulping of that material will presently be described in detail, though it is to be understood that the utility of the invention is not restricted to any specific material but it may be used for distintegrating and pulping many other fibrous materials including natural products, such as grasses, peat, woody materials, and the like.

In general, my invention may be described as involving the steps of preliminarily softening the material to be treated and suspending it in water, and then causing the water and suspended material to flow through a closed circuit, during which defelting operations are performed upon it and fresh material is continuously introduced into the circulating stream while pulped material is continuously withdrawn therefrom.

In practicing the method in the treatment of paper, I first reduce the paper to pieces of relatively small size in any convenient manner and for this purpose may put the stock through a hammer mill of conventional design. The paper is then softened and placed in a condition suitable for pulping and for this purpose, I soak the paper in warm water of a temperature of about 160 to 170° F. Preferably, the soaking is carried on in a suitable vat which contains means by which the paper and water may be mildly agitated and I place in the vat a charge of about 90% to 95% water, 5% to 10% of paper (dry weight) and a small quantity, such as 2% to 3% of the dry weight of the paper, of a mild detergent of any well known type. For this purpose, I may use soap, soda ash, potassium abietate, and other materials well known in the art. The soaking and agitation of the paper is continued for a short time until the paper is thoroughly softened and the detergent well distributed through it.

The purpose of this preliminary treatment is to soften the paper so that it can be easily operated on in subsequent steps of the process and it will be understood that the proportions above given are not critical and may be varied considerably with good results, depending on the character of the paper stock being treated and the kind of detergent employed. The treatment will also be varied, as is well known in the art, when other materials than paper are to be defibred. I have found that paper may be pulped in my process by the use of mild detergents and the detergent may be wholly omitted in some cases, this use of mild chemicals as a detergent preventing injury to the fibres.

In tearing apart and disentangling the fibres of the paper without doing injury thereto, I take advantage of the inertia of the pieces of paper suspended in the liquid and subject the suspended paper to the impact of high velocity blades. These blades strike the paper at one point while it is yieldingly held elsewhere by the liquid and the blades tear the paper apart, releasing the materials usually present therein and freeing and separating the fibres. In order to carry on the process at a rapid output rate, I employ a series of sets of blades in a chamber and construct the blades so that they both tear apart the material and propel it forward to the next set of blades. The blades used are of a rotary type and since they impart a high rotational velocity of the material, it is evident that measures must be taken to prevent loss of effectiveness of the succeeding blades in the series by reason of the velocity of the material supplied to them. I have found it possible to overcome this difficulty and secure an additional disintegrating action by converting the rotational movement of the material leaving the first set of blades into a rectilinear movement, as, for example, by interposing stator vanes in the chamber between the sets of rotary impact blades. These stator vanes are preferably spaced from the blades so that a shearing action is avoided which would shorten the fibres but as the material leaves the blades and enters the spaces between the vanes, the direction of its movement is abruptly changed and this, with the inertia of the fluid and paper produces a further disintegrating effect.

The disintegrating operations are carried on continuously and without interruption, and for this purpose I cause the rotary defibring elements to serve as means for propelling the material through a closed circuit. At one point in this circuit, the material is collected in a classifying chamber from which the pulped product is continuously withdrawn. Fresh stock to be

treated is mingled with the stream of material leaving the classifying chamber just in front of the exit, being drawn rapidly therefrom by the suction action of the disintegrating and impelling devices.

I am aware that it has been proposed heretofore to employ rotary impact blades for disintegrating and propelling material to be pulped through a closed circuit but in those prior machines with which I am familiar the operation is carried on by batches, and the blades are relatively long and no attempt is made to convert the rotational movement of the material leaving the blades in the rectilinear movement. When such long blades are employed, a portion of the material is acted on by parts of the blades near their axes of rotation, which parts move at much lower velocity than the extreme ends of the blades. The material is, therefore, not efficiently acted on by such blades. According to my method, I so confine the circulating stream of material and fluid through a portion of its circuit as to create a thin annular stream into which the ends of the blades project. The material in this stream is acted on by blades moving with an extremely high velocity, and the rotary movement of the material leaving the blades is converted into rectilinear movement, with the result that the efficiency of the pulping action is greatly increased.

For a better understanding of my method, reference may be had to the accompanying drawing, in which

Fig. 1 illustrates in vertical section a machine suitable for carrying out the method; and

Fig. 2 is a sectional view of the machine on the line 2—2 of Figure 1.

In the drawing, the machine is illustrated as including a standard 10 mounted on a suitable base 11, this standard being constructed at its top to form the bottom 12 of a generally vertical cylindrical classifying or vortex chamber 13. Projecting upward above the bottom are side walls 14 and mounted on the inner face of the side walls is a partition 15 of generally conical shape having an open top 16. The space 17 between the outer surface of the partition and the side walls of the chamber serve as a collecting chamber from which pulped material may be discharged through an outlet 18. The chamber is provided with an exit opening defined by a tubular partition 19 mounted in a neck 20 projecting upwardly from the bottom and extending down from the exit opening is a hopper 21 terminating in a chamber 22.

A plurality of defibring chambers or tubes 23 extend radially from chamber 22 and are in communication therewith. Four such tubes are employed in the machine illustrated and they are arranged in pairs in upper and lower levels, with the tubes in each level aligned. In aligned tubes is a drive shaft 24 which extends out through gland devices generally designated 25 at the ends of the tubes. Each shaft is mounted in bearings 26 on standards 27 and is provided with a suitable coupling element 28 by which it can be connected to a source of power so as to be driven at a high speed such as 3600 R. P. M.

Mounted on the shaft within each tube are sets of disintegrating and impeller blades 29 and these blades terminate close to the inner wall of liner members 30 mounted in the tube. Between the liner members are sets of stator vanes 31 projecting into the tube, the faces of the vanes lying radially so that passages are formed between the vanes which extend axially of the tube. The shaft is provided with collars 32 between the sets of blades and with conical collars 33 beyond each of the end sets of blades. These collars serve to reduce the working space within the tube and confine the material flowing through the tube to a thin annular stream into which the ends of the blades project.

The outer end of each tube is formed with a discharge elbow 34 connected to an elbow 35 which is in turn connected to a nozzle 36 opening tangentially into the classifying chamber just above the bottom thereof.

A feed pipe 37 extends down into the chamber and terminates below the top of the conical partition and in alignment with the tubular partition 19.

In the operation of the machine, stock to be pulped is introduced continuously through the feed pipe and passes at once into hopper 21 and chamber 22. The material is drawn out of the chamber 22 by the suction action of the blades and as the paper suspended in water reaches the blades in the form of a thin annular stream, the high velocity ends of the blades strike the paper with a powerful impact. Due to the inertia of the paper in the water, the blades tear the paper apart, separating the fibres and freeing the loading materials. The blades also impart a high rotational velocity to the paper and water but this rotational movement is converted into rectilinear movement by the action of the stator vanes. The paper and water enter passages defined by the vanes and the collars on the shafts which the ends of the vanes just clear and the material flows through these passages to the next set of blades. The operations described are repeated until the material is propelled out of the tube by the last set of blades and the stream flows with a rapid whirling motion through the discharge line and enters the classifying chamber through the tangential nozzles.

The material entering the classifying chamber has a rapid whirling motion and it moves upward along the side walls of the chamber and then upwardly and inwardly on the under surface of the inclined partition. Vortical downward flow then occurs with the main current passing out of the chamber through the exit to the tubes. In the body of liquid and paper within the classifying chamber, the larger particles of paper tend to remain in the main stream while the smaller, more completely defibred pieces are thrown outward by centrifugal action. This action takes place because the water opposes the outward flow of the larger, bulkier particles in the upwardly moving current, and only the smaller particles can pass through the liquid into the films which are close to the chamber walls. As fresh stock is continually fed to the device, the body of fluid in the classifying chamber rises higher and higher until it overflows and, since the overflow is from the periphery of the stream, the material discharged includes the smaller and more completely defibred pieces, while the larger pieces pass down to the tubes for further disintegration.

When the machine is in regular operation, the rate at which material is discharged equals the rate of feed of fresh stock and the character of the material discharged depends upon the number of times that the material is subjected to the disintegrating action. The number of passages of the material through the tubes depends on the ratio of feed of fresh stock to the rate of total

flow through all the dispersing tubes so that with a given rate of flow of fresh stock, a pulp of increased dispersion may be produced by increasing the rate of flow through the tubes or with the tube flow constant, the freeness of the pulp may be increased by decreasing the rate of supply.

By confining the circulating material in the form of a thin annular stream in the tubes, the defibring blades act with great effectiveness and the defibring action is assisted by the impact of the material leaving the blades upon the sides of the stator vanes and by the wall friction in the tube and discharge line. Ordinarily the stator vanes will be spaced from the edges of the blades so as to prevent a shearing action which would shorten the fibres but with some materials it may be desirable to take advantage of this shearing action to increase the speed of pulping. In that event, the stator vanes will clear the edges of the blades by only a small amount. Also, in some cases, it may be desirable to omit the stator vanes entirely. In that case, it is desirable to construct the blades of the several sets so that they have an increasing pitch in the direction of movement of the material. When blades of that type are employed, it is possible to maintain the effectiveness of the later blades in the series in spite of the rotational velocity imparted to the material by the preceding blades.

I contemplate that other devices than that described may be employed for the practice of my method but in all machines in which the principles of my method are carried on, the material will be constantly circulated with fresh material continuously added and pulp continuously withdrawn. Also, I find it highly advantageous to confine the material in the defibring region to the form of a thin annular stream so that the materials may be acted on only by those portions of the blades which are moving at the highest angular velocity. In the circuit, it is necessary to provide a chamber in which material may accumulate and I take advantage of this by constructing the chamber so that it effects a classifying action as well as serving as a collecting means.

The apparatus disclosed in this application for the practise of the new method is similar to that set forth and claimed in the applicant's copending application, Serial No. 572,130, filed October 30, 1931, and this apparatus, with certain changes, may be employed to practice the process set forth and claimed in the applicant's copending application, Serial No. 572,132, filed October 30, 1931.

What I claim is:

1. A method of disintegrating a material, which comprises moving the material suspended in a fluid through a closed circuit and during a part of the travel of said material confining it so that it has the form of a thin annular stream, subjecting the material in said stream to high velocity impact action and simultaneously imparting rotational movement to the material, continuously withdrawing treated material from the circulating stream and adding fresh stock to the stream.

2. A method of disintegrating a material, which comprises moving the material suspended in a fluid through a closed circuit and during a part of the travel of said material confining it so that it has the form of a thin annular stream, subjecting the material in the annular stream to high velocity impact action resisted by the inertia of the suspended material and imparting rotational movement to the material, converting the rotational movement of the material to rectilinear movement and simultaneously subjecting it to impact action, continuously withdrawing treated material from the circulating stream, and continuously adding fresh stock to the stream.

3. A method of disintegrating a material, which comprises moving the material suspended in a fluid through a closed circuit and during a part of the travel of said material confining it in the form of a thin annular stream, subjecting the material in the annular stream to high velocity impact action resisted by the inertia of the suspended material, said action being repeated at spaced points within said tube and imparting rotational movement to the material, converting the rotational movement of the material to rectilinear movement between adjacent points of impact action, continuously withdrawing treated material from said stream, and continuously adding fresh stock to said stream.

4. A method of producing pulp, which comprises moving fibrous material suspended in water through a closed circuit including a classifying chamber, disintegrating the material during its movement outside the chamber, subjecting the material in said chamber to centrifugal and vortex actions to effect discharge of pulped material of selected characteristics from the circulating stream, and adding fresh stock to the circulating stream.

5. A method of producing pulp which comprises moving fibrous material suspended in water through a closed circuit including a classifying chamber, disintegrating the material during its movement outside the chamber, introducing the material into the chamber near the bottom thereof and in such manner as to produce an upwardly moving stream having an inward spiral movement, withdrawing pulped material from the stream near its periphery, and adding fresh stock to the stream.

6. A method of producing pulp which comprises moving fibrous material suspended in water through a closed circuit including a classifying chamber, disintegrating the material during its movement outside the chamber, introducing the material from the disintegrating operation into the chamber near the bottom thereof and in such manner as to produce an upwardly moving stream having an inward spiral movement, withdrawing pulped material from the stream near the upper surface thereof, and adding fresh stock to the circulating material.

7. A method of producing pulp which comprises moving fibrous material suspended in water through a closed circuit including a classifying chamber, disintegrating the material during its movement outside the chamber, introducing the material from the disintegrating operation into the chamber near the bottom thereof in such manner as to produce an upwardly moving stream having an inward spiral movement, said stream leaving the chamber with a vortical flow, withdrawing pulped material from said stream near the periphery thereof, and adding fresh stock to the circulating material.

8. A method of producing pulp which comprises moving fibrous material suspended in water through a closed circuit including a classifying chamber, disintegrating the material during its movement outside the chamber, introducing the material from the disintegrating operation into the chamber near the bottom there-

of and in such manner as to produce an upwardly moving stream having an inward spiral movement, said stream leaving the chamber with a vortical flow, withdrawing pulped material from said stream near its periphery, and adding fresh stock to the circulating material leaving the chamber.

9. A method of disintegrating a material which comprises moving the material suspended in a fluid through a closed circuit and during a part of the travel of said material confining it in the form of a thin annular stream within a tube, producing a relatively high velocity low volume flow within said tube and relatively low velocity high volume flow in another part of the circuit, subjecting the material to disintegrating operations in the high velocity portion of the circuit, and continuously withdrawing treated material from the low velocity portion of the circuit and adding fresh stock thereto.

10. A method of producing pulp from paper which comprises suspending the paper in water containing a detergent, moving the paper and water through a closed circuit, disintegrating the paper to free the fibres during the circulating movement, continuously withdrawing water and pulp from the circulating stream, and continuously adding fresh stock to the stream.

11. A method of producing pulp of selected characteristics from fibrous material which comprises moving the material suspended in water through a closed circuit and during a part of the travel of said material confining it in the form of a thin annular stream within a tube, disintegrating the material by subjecting it to high velocity impact action while it is passing through said tube, continuously withdrawing the pulped material from the circulating stream and adding fresh stock to the stream at the same rate, and varying the rate of movement of the material through the circuit and thereby controlling the number of times the material will be subjected to disintegrating operations in order to control the characteristics of the material withdrawn from the stream.

12. A method of producing pulp of specified characteristics from fibrous material, which comprises creating and confining within a tube a thin annular high velocity stream of material suspended in water, disintegrating the material during its movement through said tube, temporarily storing the disintegrated material and water delivered by said stream, continuously withdrawing the pulped material and water from said store, continuously adding fresh material suspended in water to said store, the rate of feed and the rate of withdrawal being the same, continuously supplying water and material from said store to said stream, and regulating the character of the pulped material discharged by controlling the ratio between the rate of feed and the rate of movement of the material in said stream.

13. A method of disintegrating a material which comprises moving the material suspended in a fluid through a closed circuit and during a part of the travel of said material confining it to give it the form of a thin annular stream, subjecting the circulating material in said stream to high velocity impact action resisted by the inertia of the suspended material and simultaneously imparting rotational movement to the material, converting the rotational movement of the material to rectilinear movement in a plurality of separate streams, continuously withdrawing treated material from the circulating stream, and adding fresh stock thereto.

14. A method of distintegrating a material which comprises moving the material suspended in a fluid through a closed circuit and during a part of the travel of said material confining it so that it has the form of a thin annular stream, subjecting the material in said stream to high velocity impact action and simultaneously imparting rotational movement to the material, segregating material distintegrated to a selected degree from the remainder of the circulating material, continuously withdrawing a portion of the segregated material, the remainder returning to circulation, and continuously adding fresh stock to the circulating stream.

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