Feb. 28, 1939. M. L. EDWARDS 2,148,448

METHOD AND APPARATUS FOR TREATING PAPER PULP

Filed Jan. 20, 1936 2 Sheets-Sheet 1

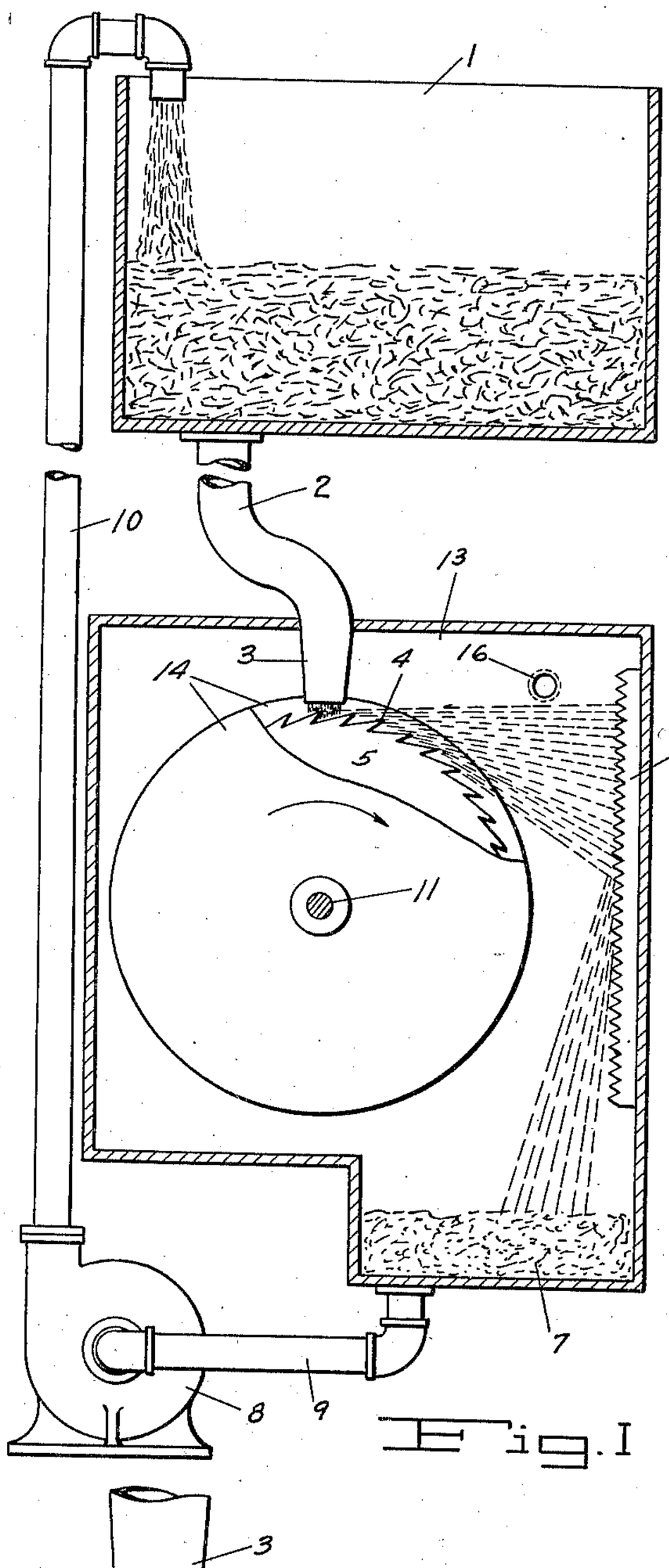

Fig. I

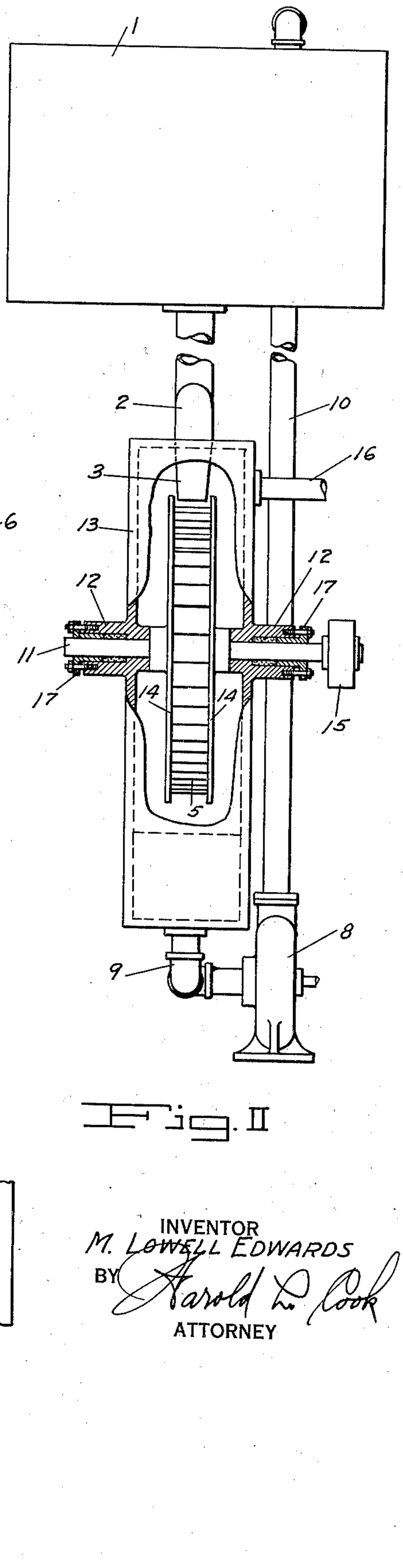

Fig. II

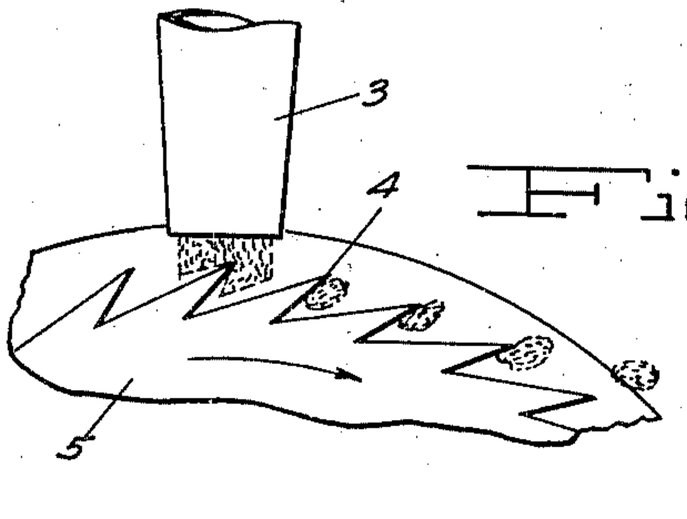

Fig. III

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METHOD AND APPARATUS FOR TREATING PAPER PULP

Filed Jan. 20, 1936 2 Sheets-Sheet 2

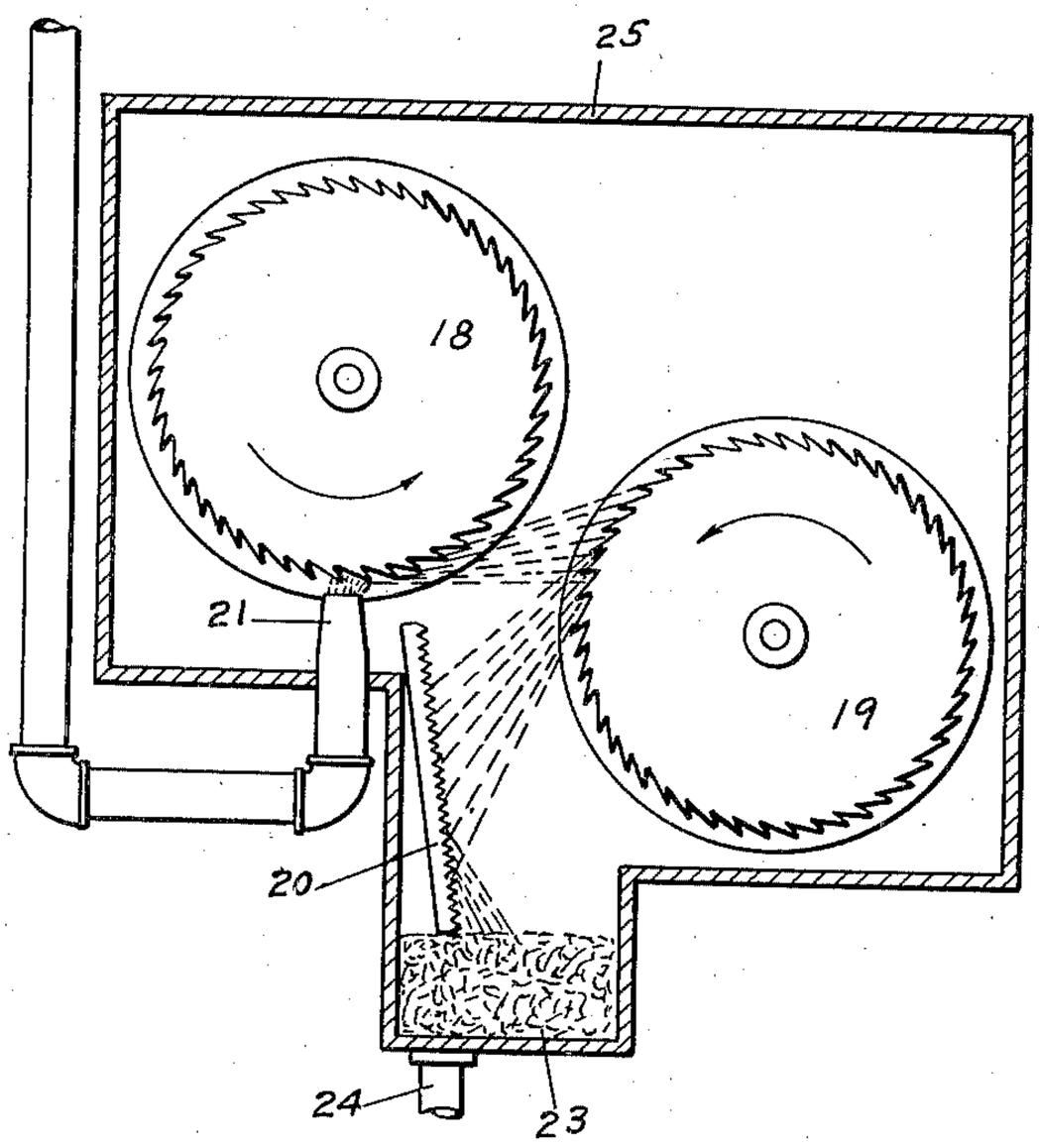

Fig. IV

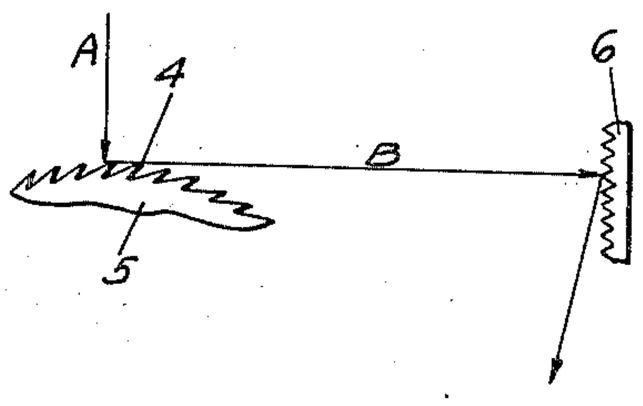

Fig. VI

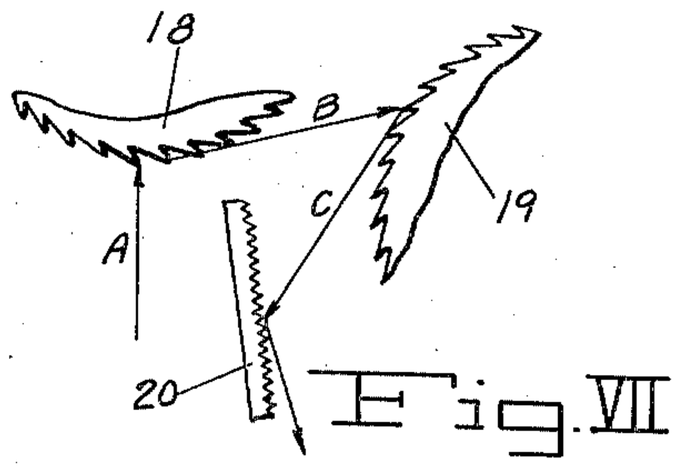

Fig. VII

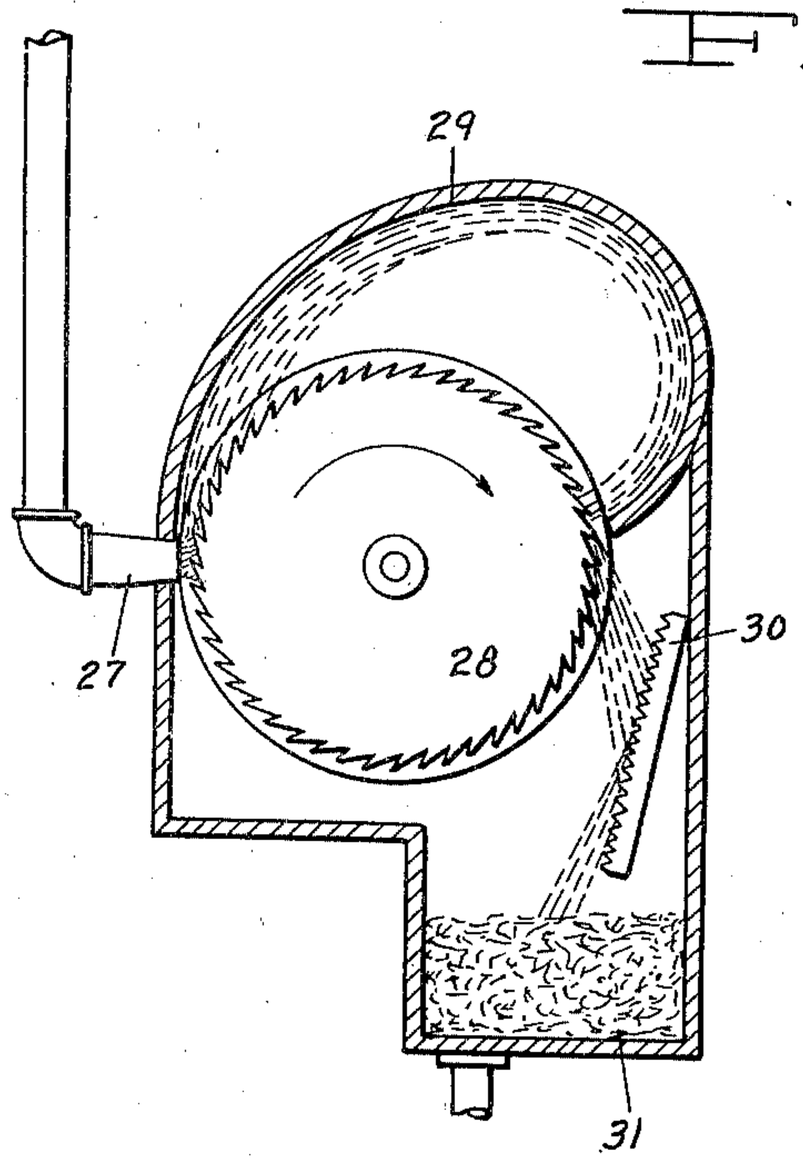

Fig. V

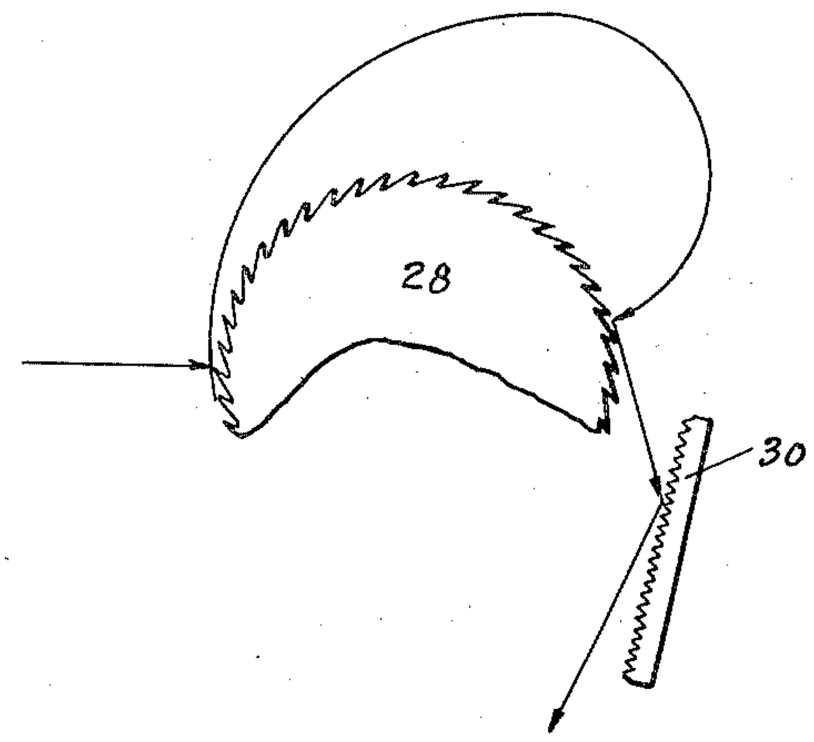

Fig. VIII

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Patented Feb. 28, 1939 2,148,448

UNITED STATES PATENT OFFICE

2,148,448

METHOD AND APPARATUS FOR TREATING PAPER PULP

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Application January 20, 1936, Serial No. 59,953

14 Claims. (Cl. 92—20)

This invention relates to the art of making paper and other fiber products, and has particular reference to a new and improved method and apparatus for refining paper pulp.

To facilitate a proper understanding of the present invention and the manifold advantages thereof, it should be remarked that in recent years it has become substantially the universal practice in the pulp and paper industry to introduce successive batches of paper stock into beating engines of the type employing a tub provided with a Hollander roll and a bed plate to break up fiber clusters and cause fibrillation of the individual fibers. In the operation of the beater engine the pulp is circulated horizontally about a midfeather by the beating roll, whereby the pulp is caused to pass and repass between the roll and the bed plate. A further step in the refinement of pulp has been universally carried on in a Jordan, in which further fibrillation is accomplished and the fiber length is reduced.

These processes require the consumption of a great deal of power, and the beating operation involves a large amount of time, it being not uncommon to subject a single batch of pulp to the action of the beating engine for a period extending over several hours. Therefore, any endeavor to lessen the cost of production must, of necessity, find a means or method of reducing the power consumption to a minimum, or of shortening the time during which the power must be expended.

A comparatively recent adjunct to the beater engine is a pump and nozzle arrangement, by means of which the stock is subjected to substantial pressure and projected against a serrated target to break up or separate the bundles of fibers by impact. The pulp is discharged from the nozzle at a relatively high velocity, and is projected against the target with sufficient violence to break up the bundles of fibers. By means of this expedient, the time necessary to beat and properly reduce the stock has been shortened, and the consumption of power per unit of pulp has been materially lessened. It has developed, however, that the velocities attainable by ordinary pumping means are not sufficient to cause complete reduction of the pulp by impact with the target, and this means has been used only to augment the disintegrating action of the beating engine by separation of the fiber clusters.

Applicant has discovered, however, that the velocity of the pulp is an extremely important factor in determining the amount of reduction of the pulp resulting from its impact with a target. As the velocity increases at which pulp is discharged against the target, the more effective becomes this method of treatment, and it has been observed that as the velocity of impact is increased the action on the pulp increases much more rapidly than the velocity.

The present invention is, therefore, directed to a method of refining paper pulp by hurling the pulp against a target at such velocities as will cause the fiber clusters to be impinged thereagainst with a violence of almost explosive proportions.

This explosion of the fiber clusters is, applicant believes, due to the instantaneous dissipation of kinetic energy in the fiber clusters in the form of friction between the pulp fibers due to a low coefficient of restitution of the pulp material. The inertia of the pulp at the instant of impact tears the fiber clusters apart, and tends to break the longer fibers as a result of the complete change in physical structure of the fiber bundles as they strike the target.

It is an object of the present invention to provide a method and apparatus for the reduction and refinement of paper pulp which will reduce the amount of time required to thoroughly treat a given amount of pulp stock, and which will reduce the consumption of power required to effect the treating operation.

A further object of the invention is to provide a method and apparatus for treating paper pulp in a much shorter time and at a lower cost than can be done by processes and apparatus heretofore in use.

A further object of the invention is to provide a method and apparatus for the reduction and refinement of paper stock employing low pressures and high velocities to cause the pulp to be impinged against an impact member with considerable violence.

Additional objects and advantages will become apparent as the description proceeds in connection with the accompanying drawings, it being understood that the drawings are illustrative only, and that various changes in form, proportion, size and details of construction within the scope of the claims may be resorted to without departing from the spirit or sacrificing any of the advantages of the invention.

Referring to the drawings, wherein like reference characters denote like parts throughout the several views:

Figure I is a sectional side elevation of an apparatus embodying the present invention.

Figure II is a front view, partly in section, of the apparatus illustrated in Figure I.

Figure III is a fragmentary detail of the apparatus, illustrating the manner of delivering pulp to the high velocity buckets and discharging it therefrom.

Figure IV is a side elevation, partly in section, of a modified form of apparatus employing the present invention.

Figure V is a sectional elevation of a further modification of apparatus employing the present invention.

Figure VI is a diagrammatical analysis of the stream of pulp as acted upon by the apparatus illustrated in Figure I.

Figure VII is a diagrammatical analysis of the stream of pulp as acted upon by the apparatus illustrated in Figure IV.

Figure VIII is a diagrammatical analysis of the stream of pulp as acted upon by the apparatus illustrated in Figure V.

Preliminary to a more detailed description of the illustrated embodiment of the invention, it may be stated in brief that, in its simplest form, it embodies the principle of accelerating the pulp by impact with a high velocity wheel and causing it to impinge against a suitable target. The pulp is subjected to two impacts, the first as the wheel strikes the pulp to accelerate its velocity, and the second as the pulp strikes the stationary target after being hurled from the wheel. Thus the pulp is subjected to successive treatments without the consumption of more power than is required for its major acceleration.

Referring to Figures I and II of the drawings, the pulp stock is delivered to the vat or tank 1, from whence it is conveyed by the pipe 2 to a point of discharge from the nozzle 3 into the path of the toothed projections 4 which form the periphery of the high velocity vehicle, which may be in the nature of a wheel 5. Each of the projections 4 is undercut on one side. This side may be considered as the back side of the bucket formed by the two adjacent projections. The pulp is discharged from the periphery of the wheel 5 by centrifugal force, and is impinged against a stationary target 6, from which it drops into the sump 7. Leading from the sump 7 to a pump 8 is a pipe 9, which may redeliver the pulp to the tank 1 via the pipe 10, as shown, or may deliver the pulp to other apparatus for further treatment, as may be desired.

In the illustrated embodiment of the invention, the tank 1 is placed at an elevation sufficiently above the reducing engine to permit the pulp to flow through the delivery pipe 2 by gravity. The pressure thus exerted upon the pulp is negligible, and need only be sufficient to insure continuous delivery of the pulp to the reduction engine. Thus it will be appreciated that very low pressures may be utilized to move the stream of pulp through the pipe 2, as distinguished from pressures heretofore required to discharge pulp from a nozzle so as to cause it to be projected against an impact member with any appreciable velocity.

The wheel 5 is mounted upon a shaft 11 which is journaled in suitable bearings 12 in the side walls of the casing 13. The wheel 5 is formed with side plates 14 which form the sides of buckets formed by the spaced teeth 4, these side plates extending beyond the ends of the teeth to guide the stream of pulp and to prevent it splashing over the sides of the wheel. From Figures 1 and 2 it will be seen that the opening of the nozzle 3 is adjacent and coextensive with certain buckets on the wheel 5, which buckets are formed by the adjacent projections 4 and the side plates 14. The distance between the projections may be varied in relation to the size of the nozzle opening, without changing this coextensive relationship. Power to drive the wheel 5 may be transmitted to the pulley 15 from any suitable source.

It is intended that the wheel 5 may be propelled at a speed giving peripheral velocities varying between 200 and 400 feet per second depending upon the amount of treatment required. It will be recognized that the peripheral velocity of the wheel 5 determines the velocity with which the pulp impinges against the target 6. As best illustrated in Figure III, the flow of pulp discharged from the nozzle 3 is directed towards toothed projections 4 of the wheel 5 and into the buckets or spaces therebetween. Each tooth strikes off a small quantity of pulp from the flow issuing from the nozzle and carries it for a short distance in the direction of travel of the tooth. Inasmuch as the tooth is following a circular course around the shaft 11, the small quantity of pulp deposited between the teeth of the wheel is thrown by centrifugal force in a direction approximately tangential to the circle of tooth rotation. As the pulp leaves the wheel 5, its velocity is approximately that of the peripheral velocity of the wheel, and it is impinged against the target 6 with such force as to cause the pulp clusters to break up with considerable violence. The target 6 preferably is serrated in planes at right or other angles, thus producing a surface of points or projections and increasing the angles at which the pulp strikes the target. The effect of the impact is to completely change the physical structure of the bundles of pulp. The pulp is subjected to a cutting, tearing and pressing action resulting in a material shortening of the fiber length, and hydration, softening and fibrillation of the fibers similarly to the treatment effected by beating engines heretofore in use. In this connection it should be explained that the cutting or breaking action on the individual fibers is in direct proportion to the length of the fibers. Since a bundle of pulp is made up of a mixture of both long and short fibers, the tendency is to shorten the longer ones without further reducing the length of the short fibers. At the commencement of the treatment, when the fibers are comparatively long, the shortening action will progress rapidly; but as the treatment progresses, the average length of the fibers will diminish more and more slowly.

The reduction engine, comprising the wheel 5 and target 6 is enclosed in an air tight casing 13, which is connected to an air pump (not shown) by a pipe 16. By this means the casing 13 may be partially vacuumized to reduce the unit weight of the atmosphere in which the machine operates, thereby decreasing the windage of the rapidly moving wheel 5 and particles of pulp. It will be noted that the bearings 12 for the shaft 11 are fitted with packing glands 17 to prevent air from leaking into the casing around the shaft. The partial vacuum within the casing 13 may be sufficient to draw the pulp into contact with the periphery of the wheel 5 for the first impact, depending upon the consistency of the pulp and the elevation and proximity of the tank 1 to the reduction engine.

In Figure VI of the drawings is a diagrammatical analysis of the treatment effected by the apparatus illustrated in Figures I and II. The line A represents the flow of pulp from the tank

l under relatively low pressure, at a velocity of approximately 50 feet per second. The first impact is with the toothed periphery of the wheel 5, the teeth striking the pulp and hurling it along the line B at a velocity approximately equal to the peripheral speed of the wheel 5, which may be driven at any predetermined speed, depending upon the character of the pulp and the treatment required. A second impact is effected when the pulp strikes the target 6, the effect thereof being to spread the fiber clusters over the face of the target with a force approximating explosive proportions, and from the face of the target the pulp drops into the sump 7 to be returned to the tank 1 or conveyed elsewhere for other and further treatment as may be desired.

In Figure IV is illustrated a reduction engine employing two impact wheels 18 and 19, and a target 20. The pulp issuing from the nozzle 21 is accelerated by impact with the wheel 18 and is hurled into the peripheral buckets of the wheel 19. Rotation of the wheel 19 further accelerates the pulp and hurls it against the target 20, from whence it drops into the sump 23, to be conveyed therefrom by the pipe 24. A casing 25 encloses the reduction engine, and the interior of the casing may be partially vacuumized by means heretofore described.

An analysis of the treatment effected by this device is illustrated in Figure VII. Presupposing a velocity of 50 feet per second at the nozzle 21, and a peripheral velocity of each wheel of from 200 to 400 feet per second, the pulp is subjected to three impacts. The first impact is indicated at A, the pulp being struck by the high velocity wheel 18, the velocity of the pulp being accelerated to approximately the peripheral speed of the wheel. Thereupon the pulp is impinged against the periphery of the wheel 19, as indicated at B, the force of the impact being measured by the combined velocity of the pulp as it leaves the wheel 18 and the peripheral velocity of the wheel 19. Thus the wheel 19 serves both as an impact member and to accelerate the velocity of the pulp and to direct it against the target 20 for the third impact, from whence it drops into the sump 23.

The impacts illustrated in Figure VI, differ from the impact on plate 20 shown in Figure VII, in that the impacts in Figure VI are direct central impacts whereas the impact on 20 in Figure VII is an oblique impact. If the mass centers of two bodies before collision move along the same straight line and the form of the bodies is such that the pressure each exerts upon the other is along this line, the impact is called "direct central impact". All other impacts are oblique.

Figure V illustrates a modified form of reduction engine in which the pulp is discharged through a nozzle 27 onto the periphery of an impact wheel 28, from whence it is hurled, by centrifugal force, along an arcuated guideway 29 which returns the pulp into contact with the wheel 28 for a second impact thereby. From the point of the second impact by the wheel 28, the pulp is hurled against a stationary target 30, from whence it drops into a sump 31 and is conveyed therefrom to any desired place of delivery. Figure VIII represents a diagrammatic analysis of the travel of the pulp and the points of impact thereof with the impact wheel and the stationary target. It is to be understood that this reduction engine may also be caused to operate in a vacuum to reduce windage, and so lessen the effect of air currents on the course of the pulp fibers.

It will be appreciated that by the herein described method of accelerating the velocity of the pulp, the consumption of power for the reduction of a given amount of pulp is very materially lessened; for the reason that it not only requires less power to accelerate the velocity of the pulp, but, due to increased action on the pulp resulting from impacts at increased velocities, the amount of time consumed for treatment is also considerably lessened. The high efficiency of the present method of treating paper pulp is due to two basic factors. The first is due to a more efficient method of obtaining high pulp velocities, as compared with the old method of using a pump and nozzle; and the second is that the pulp may be subjected to two impacts with an expenditure of power for only one acceleration of velocity.

Although there is shown and described herein a preferred embodiment of the invention, its application is not necessarily confined thereto, but may be used either in its entirety or in part, and either with or without modifications, without departing from the spirit of the invention. For example, it is not intended to limit the application of the present invention to the use of particular pressures or velocities, as it will be obvious to those skilled in the art that some stocks, such as materials which are used in cheaper classes of paper, require very little beating; while, on the other hand, stocks for papers in which such characteristics as strength, translucency, or other special features are required, must be subjected to more severe treatment in order to attain the desired end. The pressures and velocities herein mentioned are to be considered as suggestive only, and in practicing the methods herein disclosed these may be varied according to the texture of the pulp and the amount of treatment required therefor. I therefore deem myself entitled to all such uses, modifications and/or variations as fall within the spirit and scope of the claims hereto appended.

Having now described my invention and in what manner the same may be used, what I claim as new and desire to protect by Letters Patent is:

1. A method of treating paper pulp, including the step of delivering the pulp into a closed tank under a partial vacuum, striking the stock in said tank to increase its velocity, and causing it to be hurled against a target to produce a violent impact therewith.

2. A method of treating fibrous pulp which consists of directing a flow of pulp, moving said pulp at relatively low velocity, striking off small quantities of pulp from said flow to accelerate the velocity of said small quantities, and interposing an attrition member in the path of said quantities of pulp to cause the pulp to impinge on said attrition member with violent impact.

3. A method of treating fibrous pulp which consists of directing a flow of pulp, moving said pulp at relatively low velocity into contact with a high velocity member whereby small quantities of pulp are separated from said flow of pulp with sufficient force to disrupt the pulp fibres of each said small quantity.

4. A method of treating fibrous pulp which consists of directing a flow of pulp, moving said pulp at relatively low velocity into contact with a high velocity member whereby small quantities of pulp are separated from said flow of pulp with sufficient force to disrupt the pulp fibres in each

said small quantity, and of confining said small quantities at the time of impact with the high velocity member to reduce scattering of said small quantities.

5. A method of treating fibrous pulp which comprises striking a small quantity of said pulp with sufficient force to disrupt its fibres and to give it velocity, confining said quantity at the time of impact to reduce scattering of said quantity, and of interposing an attrition member in the path thereof to cause said pulp to impinge upon said attrition member.

6. A method of treating fibrous pulp which includes the steps of striking a small quantity of pulp with sufficient force to disrupt its fibres and give it a high velocity, and of interposing an attrition member in the path of said small quantity of pulp to cause said pulp to impinge up said attrition member to further refine said pulp.

7. A method of treating fibrous pulp which includes the steps of directing said pulp in a continuous stream, striking off small quantities of pulp from said stream with sufficient force to disrupt the pulp fibres in each small quantity of said pulp and to give said quantity a high velocity, and of interposing an attrition member in the path of said small quantities of pulp to cause them to impinge upon said attrition member to further refine said pulp.

8. A method of treating fibrous pulp which includes the steps of directing said pulp in a continuous stream, striking successive small quantities of pulp from said stream with sufficient force to disrupt the fibres in said small quantities of pulp and to give said quantities a velocity, and of interposing an attrition member in the path of said small quantities of pulp to cause them to impinge upon said attrition member to further refine said pulp.

9. A method of treating fibrous pulp comprising delivering pulp into a closed tank under a partial vacuum, striking off small quantities of said pulp in said tank with sufficient force to disrupt the pulp fibres, and of confining said quantities at the time of impact to reduce scattering of the pulp fibres.

10. A method of treating fibrous pulp comprising delivering pulp into a closed tank under a partial vacuum, striking off small quantities of said pulp as it is delivered into said tank with sufficient force to disrupt the pulp fibres and to give said pulp high velocity, and of interposing an attrition member in the path of said small quantities of pulp to cause them to impinge upon said attrition member to further refine said pulp.

11. A method of treating fibrous pulp including the steps of directing a flow of pulp into a closed tank containing a gaseous fluid of a unit weight less than normal atmospheric, striking off small quantities of said pulp as it is delivered into said tank with sufficient force to disrupt the pulp fibres and to accelerate the velocity of said small quantities, and interposing an attrition member in the path of said small quantities of pulp to cause said small quantities to impinge thereon to further refine said pulp.

12. A method of treating fibrous pulp including the steps of directing a flow of pulp, moving said pulp at relatively low velocity into contact with a high velocity member whereby to strike off small quantities of said flow with sufficient force to partially refine said pulp and to accelerate the velocity of said small quantities, and interposing an attrition member in the path of said small quantities to cause said pulp to impinge on said attrition member to further refine said pulp.

13. An apparatus for treating fibrous pulp, comprising means to deliver a flow of pulp to said apparatus at relatively low velocity, a pair of high velocity impact members, an attrition member, one of said high velocity impact members being so constructed and arranged as to strike off small quantities of pulp from said flow and hurl said small quantities onto the periphery of the other of said impact members, the second said impact member being so constructed and arranged as to receive the pulp from the first impact member and then hurl it against the attrition member.

14. A method of treating fibrous pulp, including the steps of delivering the pulp into a closed tank containing a gaseous fluid of a unit weight less than normal atmospheric, striking off small quantities of pulp from the flow of pulp in said tank to accelerate the velocity of each small quantity of pulp, and causing it to be hurled against a target to produce a violent impact therewith.

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