June 14, 1938. W. FINNEGAN 2,120,697

APPARATUS FOR DISINTEGRATING FIBROUS SUBSTANCES

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Fig. 1.

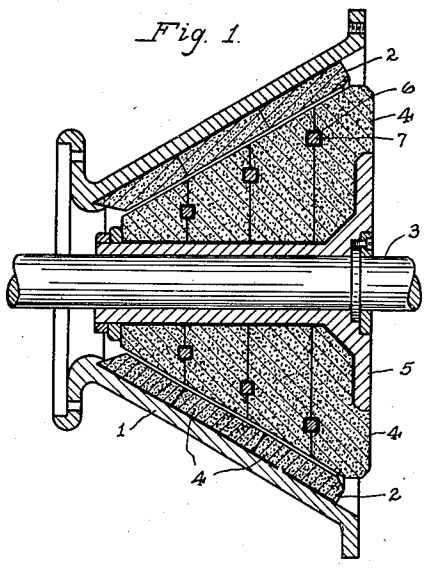


Fig. 2.

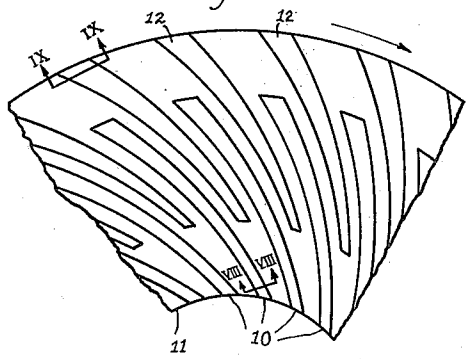


Fig. 3.

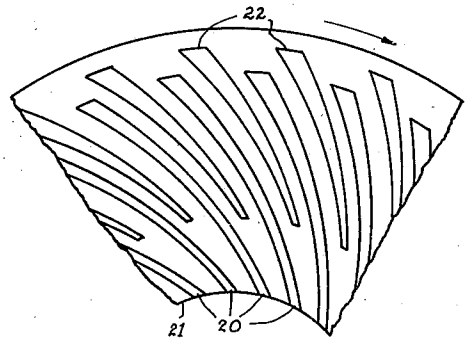
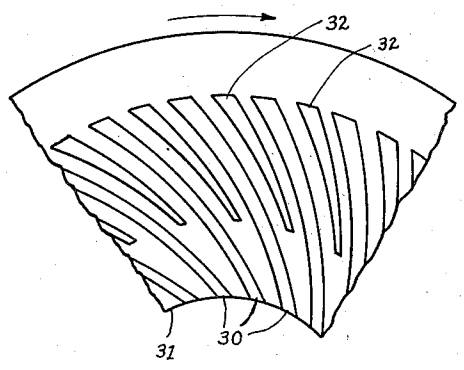


Fig. 4.



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Fig. 5.

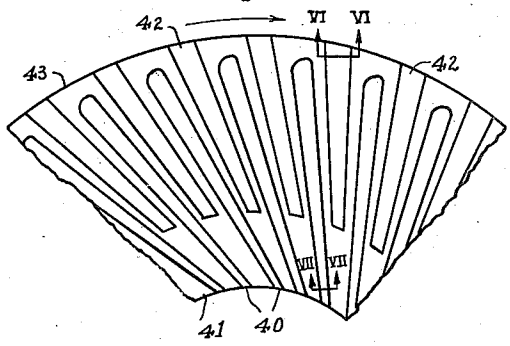


Fig. 6.

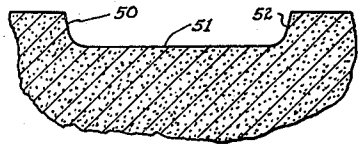


Fig. 7.

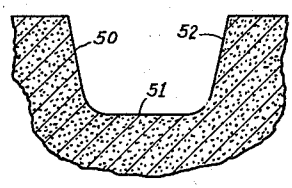


Fig. 8.

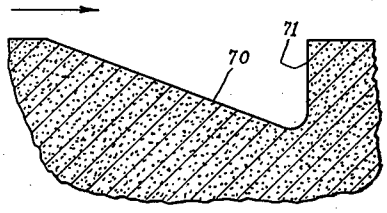
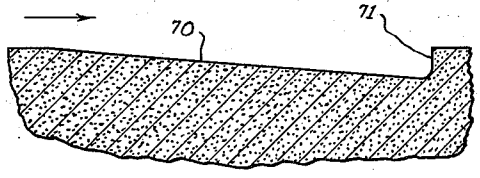


Fig. 9.



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UNITED STATES PATENT OFFICE

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APPARATUS FOR DISINTEGRATING FIBROUS SUBSTANCES

William Finnegan, Kenogami, Quebec, Canada, assignor, by mesne assignments, to The Carborundum Company, Niagara Falls, N. Y., a corporation of Delaware

Application August 5, 1935, Serial No. 34,671

13 Claims. (Cl. 92—27)

This invention relates to a machine of the class commonly referred to as Jordan engines or refiners, and has for its object the provision of a machine of improved characteristics and performance.

Machines of this class are used in the paper making mills in an attempt to salvage the coarse material screened out of the pulp before the latter goes to the paper making machines, by converting it to a more suitable condition for use somewhere in the paper making art.

The amount of coarse material actually salvaged heretofore in the above manner has been only a small percentage of the total coarse material produced because the refining machines previously known have not operated in such manner as to make it economical to attempt to reclaim more than a small portion of the material. The useful product of the refiners heretofore known has been of a quality inferior to that of the better grades of pulp, and, unless the material was repeatedly passed through the refiner, the quantity of usable pulp obtained was small.

The machine of the present invention not only converts a greater amount of waste material into useful pulp but it also produces a very much higher grade of material.

The nature of the present invention will be made clearer by reference to the accompanying drawings, in which:

Figure 1 is a longitudinal cross section of that part of a refiner to which the present invention relates.

Figure 2, 3 and 4 are portions of the developed surface of a refiner plug illustrating various arrangements of the grooves.

Figure 5 is a portion of the developed surface of a refiner lining illustrating one arrangement of grooves.

Figure 6 is a sectional view on the line VI—VI of Figure 5 illustrating the shape of a liner groove at the large end of the shell.

Figure 7 is a sectional view on the line VII—VII of Figure 5 illustrating the shape of a liner groove at the small end of the shell.

Figure 8 is a sectional view on the line VIII—VIII of Figure 2 illustrating the shape of a plug groove at the small end of the plug.

Figure 9 is a sectional view on the line IX—IX of Figure 2 illustrating the shape of a plug groove at the large end of the plug.

A refiner embodying the present invention and illustrated in Figure 1 comprises a conical metal shell 1 supporting on its inner surface an abrasive lining 2, and a shaft 3 upon which are mounted abrasive elements 4 forming the conical abrasive plug 5. In the preferred embodiment of the invention the abrasive plug and the abrasive shell lining are made of different hardness and different sizes of abrasive particles; e. g. a plug in which the abrasive granules are, for the most part, of the size commonly designated as fourteen (14) grit and are bonded into a structure of medium hardness (commonly called grade) and a shell lining in which the abrasive granules are, for the most part, of the size commonly designated as twenty-four (24) grit and are bonded into a structure of harder grade than that of the plug. The converse; that is, a coarse grit shell lining and a finer grit plug, also is of advantage. The abrasive elements of 4 of the plug 5 contain registering grooves 6 into which reinforcing rings 7 are placed to strengthen the plug against centrifugal force.

In accordance with the present invention, the conical surface of the plug 5 contains a plurality of grooves arranged in a plurality of series. Figures 2, 3 and 4 illustrate three types of grooving. As shown in Figure 2, the grooves 10 originate in the edge 11 of the conical surface. Thus, the grooves 10 have their origins at the top of the truncated cone because the edge 11 is the periphery of the top. These grooves, as illustrated, broaden out as they progress toward their opposite ends or termini, which are not in the outer periphery or base of the cone, and are curved slightly. The curvature illustrated in these figures amounts to a lag of approximately 90° when the fully developed surface is rolled into the form of the truncated cone. In other words, the grooves of the plug illustrated in Figures 2, 3 and 4 traverse an angular distance of approximately 90° as they extend from their origins to their termini.

The other series of grooves 12, illustrated in Figure 2, have their origins and termini staggered with respect to the origins and termini respectively, of the grooves 10. In other words, one series of grooves bears an interdigital relationship with respect to the other series. In the particular modification shown in this figure the termini of the grooves 12 are at the outer periphery of the developed surface, or the periphery of the base of the truncated cone. The curvature of these grooves 12 is the same as that of the grooves 10.

The developed surface of the plug 4 shown in Figure 3 illustrates a modification in which one set or series of grooves 20 has the origins thereof in the edge 21 of the conical surface and the origins of a second series of grooves staggered

with respect to the origins of the first series, but with the termini of the grooves of neither series being at the outer edge or base of the cone, although the termini of the grooves of the two series are staggered with respect to each other. The curvature and other features than those just described of the grooves of this modification are the same as those of the grooves shown in Figure 2.

Figure 4 shows a developed surface portion of a plug in which there are a series of relatively long grooves **30** having their origins in the edge **31** of the truncated cone and a series of shorter grooves **33** having their origins staggered with respect to those of the first series of grooves **31**, the termini of the two series of grooves being non-staggered; i. e., the termini are in alignment. In this modification, none of the grooves extend to the outer periphery of the developed surface of the plug. Other than this difference in the lengths of the grooves of the two series, they are the same as those illustrated in Figures 2 and 3.

The grooves **10**, **12**, **20**, **22**, **30** and **32** of the various modifications of the refiner plug of this invention are narrow and deep at their origins and wide and shallow at their termini. However, grooves that increase in depth as they extend from their origins toward their termini are sometimes used. They are formed, moreover, with two sides **70** and **71** as illustrated in Figures 8 and **9**.

The section of the groove shown in Figure 8 is taken at or close to the origin of the groove as shown by the section line VIII—VIII in Figure 2, whereas the section shown in Figure 9 is taken at or close to the terminus of a groove, as shown by the line IX—IX of Figure 2. The cross-sectional area of the groove at its origin is greater than the cross-sectional area at the terminus, the ratio being, as illustrated in Figures 8 and 9, approximately two to one. Between the origin and terminus of a groove there is a gradual change in both depth and width. As can be readily seen from Figures 8 and 9, the leading side **71** of the plug groove extends in a substantially radial direction, or in other words, it is substantially perpendicular to the axis of the plug, while the trailing side of the groove has an acute angular relationship to the leading side and this acute angle constantly approaches a right angle as the groove extends from its origin toward its terminus.

The developed portion of the abrasive liner of the shell, as illustrated in Figure 5, shows two series of diagonal grooves. The grooves **40** of one series have their origins at the edge **41** of the developed surface, which, of course, becomes the top of the truncated cone when the fully developed surface is formed into a truncated cone. The termini of these grooves, **40**, are inside the boundaries defined by the edge **41** and the edge **43**. The grooves **42** of the other series have their origins and termini staggered with the origins and termini, respectively, of the grooves **40**, of the first series. As illustrated in Figure 5, the termini of the grooves **42** of the second series are at the edge **43**, or the base of the cone.

The grooves **40** and **42** of the shell liner illustrated in Figure 5 traverse an angular distance of approximately 45° as they extend from their origins to their termini, and, like the grooves of the plug, are deeper and narrower at their origins than they are at their termini, so that their cross-sectional area diminishes by approximately one-half, from the origins to the termini. The liner grooves may be formed with three sides as shown in Figures 6 and 7, as they may be formed with two sides like the plug grooves.

While the shell liner has been described thus far as having slots or grooves extending as shown in Figure 5, it is to be understood that the types of grooving for plugs illustrated in Figures 2, 3 and 4 are suitable also for shell liner grooves. It should be understood also that under certain conditions the grooves may be omitted entirely from the shell liner, in which case the grooves of the plug provide the necessary pulp distributing and pulp advancing means.

The conditions referred to above, whereby the shell liner grooves may be omitted entirely, relate to the consistency of the stock entering the refiner and these same conditions also have an important bearing on the number and the size of the slots in the plug and in the shell liner. It is not feasible to do more in this disclosure than give general statements regarding the size and number of grooves, because the number of different pulp consistency conditions and the different types of product wanted in the pulp mills is so great that specific directions for a reasonable number of cases would be quite inadequate.

It can be said, however, that the refiner of the present invention acts like a pump in that it impels the stock through it and that this pump action can be modified between wide limits to secure the balance between quantity and quality of refined stock demanded of the particular installation.

As in any pump, the refiner of the present invention will handle more low consistency material in a given time than it will of materials of high consistency. It is evident, also, that the faster the stock flows or is pushed through the refiner the less refining action there will be. Consequently there are two courses of action open, the consistency of the stock can be made less or greater, as required, in order to utilize a given set of groovings in the plug and liner; or the shell and plug can be grooved to suit the consistency of the pulp to be handled and the product required therefrom.

If the latter of the above courses is shown there are two ways to proceed, depending upon whether the stock is too thick or too thin to be handled by the refiner to give satisfactory quantity and quality of refined stock. If the stock going to the refiner is of high consistency, the number and size (cross-sectional area) of the grooves should be made relatively large, and if the stock is of low consistency the grooves should be made relatively small in number and cross sectional area. As was stated above, it is desirable in some cases to omit entirely the grooves of the liner. This condition obtains when the stock is of low consistency and the particular size, shape, and direction of the grooves in the plug are such that the rotating plug acts to pump a large volume of stock through the refiner in a given time.

The plug and liner have been described and illustrated thus far as cooperating elements in a refiner operated by rotating the plug in the direction indicated by the arrows in Figures 2, 3, 4, 8, 9 and by introducing the material to be refined at the smaller end of the refiner. It will be obvious that operation in the reverse direction, either in respect to rotation of the plug or introduction of material, will require changes in both the plug and the liner and that such changes should be in keeping with the cooperative features set forth in this disclosure.

As stated above, the various features of the

present refiner have been described for a machine in which the material to be refined is introduced at the smaller end of the machine, and the direction of rotation of the plug is as shown in the drawings. When operated in this manner the quantity of waste material economically converted to useful pulp and the quality of the refined product greatly exceed the quantity and quality heretofore obtainable.

The grooves of the shell liner and plug having their origins at the tops of the respective truncated cones serve to convey the material to be refined into the refiner and, being of such length that they do not traverse the shell liner or plug from top to base, they also serve to distribute the material undergoing the treatment over the area of the plug or shell liner. This causes the material undergoing refinement to be subjected to the action of the abrasive surfaces for a longer period of time and results in both greater breaking down of bundles of fibers to smaller bundles or even individual fibers and greater hydration of the fibers. It also causes the fibers to become suitably frayed, whereby they mat well and form a strong sheet when made into paper.

The grooves of the shell liner and plug that have their origins somewhere between the top and base of the respective truncated cones further assist in distributing the material undergoing refinement. These grooves also serve to prevent the machine from becoming clogged with the material being treated, because they extend to or close to the edges or bases of the shell and plug cones. They do not, however, permit a free and unhampered passage of the material through the machine, because, as is pointed out above and illustrated in the drawings, they become shallower as they progress toward the bases of the cones, and in certain modifications shown and described they do not extend to the bases of the cones.

It will be noted from the drawings and the foregoing description that the grooves of the shell lining and those of the plug are of different curvature, and of different angularity with respect to the axes of the cones. This produces a different type of action than that produced in refiners heretofore known and greatly enhances the spreading of the fibrous material over the surfaces of the cones.

The grooves of the plug and of the shell may increase in depth as they extend from their origins toward their termini, or they may decrease in depth depending upon the consistency of the material which is being fed to the machine and upon the quality desired at the discharge end. The best results in practice have been obtained by employing two sided grooves (like those shown in Figures 8 and 9) which decrease in depth as they extend from their origins to their termini. Such an arrangement of grooves produces a drawing action upon the stock which tends to draw out the fibers rather than to cut them up into the form of powder.

While the refiner of the present invention has been described with reference to drawings showing specific embodiments, it is obvious that the invention is not limited to the specific details shown and described, but is defined by the appended claims.

I claim:

1. In a pulp refining engine, a plug comprising a frusto-conical abrasive member having a plurality of grooves in its conical face, said grooves being arranged in a plurality of series, each series having interdigital relationship with each other series and with the origins of the grooves of the different series being toward the top of the truncated cone and in staggered relationship longitudinally of the plug, and the grooves of one series having their origins at the top of the truncated cone and extending toward but not to the base of said cone, and a frusto-conical abrasive shell around said plug and having a plurality of grooves in its conical face, said grooves being arranged in a plurality of series with the origins of the grooves of the different series being toward the top of the truncated cone and in staggered relationship longitudinally of the shell, and the grooves of one series having their origins at the top of the truncated cone forming the shell liner.

2. In a pulp refining engine, a plug comprising a frusto-conical abrasive member of abrasive granules of approximately 14 grit size having a plurality of grooves in its conical face, said grooves being arranged in a plurality of series with the origins of the grooves of the different series being toward the top of the truncated cone and in staggered relationship longitudinally of the plug, and the grooves of one series having their origins at the top of the truncated cone and extending toward but not to the base of said cone, and a frusto-conical abrasive shell of abrasive granules of approximately 24 grit size around said plug and having a plurality of grooves in its conical face, said grooves being arranged in a plurality of series with the origins of the grooves of the different series being toward the top of the truncated cone and in staggered relationship longitudinally of the shell, and the grooves of one series having their origins at the top of the truncated cone forming the shell liner.

3. In a pulp refining engine, a plug comprising a frusto-conical abrasive member of abrasive granules of approximately 24 grit size having a plurality of grooves in its conical face, said grooves being arranged in a plurality of series with the origins of the grooves of the different series being toward the top of the truncated cone and in staggered relationship longitudinally of the plug, and the grooves of one series having their origins at the top of the truncated cone and extending toward but not to the base of said cone, and a frusto-conical abrasive shell of granules of approximately 14 grit size around said plug and having a plurality of grooves in its conical face, said grooves being arranged in a plurality of series with the origins of the grooves of the different series being toward the top of the truncated cone and in staggered relationship longitudinally of the shell, and the grooves of one series having their origins at the top of the truncated cone forming the shell liner.

4. In a pulp refining engine, a plug comprising a frusto-conical abrasive member with two series of spiral grooves in the conical face thereof, the origins of one series being staggered longitudinally of the plug with the origins of the other series, the grooves of one series having their origins at the top of the truncated cone and extending toward but not to the base of the truncated cone and the grooves of the other series having their origins toward the top of the truncated cone and extending toward the base of the truncated cone, and a frusto-conical abrasive shell around said plug and having two series of diagonal grooves in the conical face thereof, the origins of one series being staggered longitudinally of the shelf with the origins of the other series, the grooves of one of said series having their origins at the top of the truncated cone and the

grooves of the other series having their origins toward the top of the truncated cone and extending toward the base of the truncated cone, the grooves of both the plug and the shell being wider and shallower as they extend from origins to their termini.

5. In a pulp refining engine, a plug comprising a frusto-conical abrasive member with two series of two sided spiral grooves in the conical face thereof, the origins of one series being staggered with the origins of the other series, and the grooves of one series having their origins at the top of the truncated cone and extending toward but not to the base of the truncated cone, the said grooves having one side thereof extending in a substantially radial direction and being wider and shallower as they extend from their origins to their termini, and a frusto-conical abrasive shell around said plug and having two series of diagonal grooves in the conical face thereof, the origins of one series being staggered with the origins of the other series and the grooves of one of said series having their origins at the top of the truncated cone.

6. In a pulp refining engine, a plug comprising a frusto-conical abrasive member with two series of two sided spiral grooves in the conical face thereof, the origins of one series being staggered with the origins of the other series, and the grooves of one series having their origins at the top of the truncated cone and extending toward but not to the base of the truncated cone, the said grooves having one side thereof extending in a substantially radial direction and being wider and shallower as they extend from their origins to their termini, and a frusto-conical abrasive shell around said plug and having two series of diagonal grooves in the conical face thereof, the origins and termini of one series being staggered with the origins and termini, respectively, of the other series and the grooves of one of said series having their origins at the top of the truncated cone, and the grooves of the other series having their termini at the base of said cone.

7. In a pulp refining engine, a plug comprising a frusto-conical abrasive member with two series of spiral grooves in the conical face thereof, the origins and termini of one series being staggered longitudinally of the plug with the origins and termini, respectively, of the other series, the grooves of one series having their origins at the top of the truncated cone and extending toward but not to the base of the truncated cone and the grooves of the other series having their origins toward the top of the truncated cone and extending toward the base of the truncated cone, said last series of grooves being interdigitated with said first series.

8. In a pulp refining engine, a plug comprising a frusto-conical abrasive member with two series of two sided, spiral grooves in the conical face thereof, the origins and termini of one series being staggered with the origins and termini, respectively, of the other series, and the grooves of one series having their origins at the top of the truncated cone and extending toward but not to the base of the truncated cone, said grooves being wider and shallower as they extend from their origins to their termini.

9. In a pulp refining engine, a plug comprising a frusto-conical abrasive member with two series of two sided, spiral grooves in the conical face thereof, the origins and termini of one series being staggered with the origins and termini, respectively, of the other series, and the grooves of one series having their origins at the top of the truncated cone and extending toward but not to the base of the truncated cone, the said grooves having one side thereof extending in a substantially radial direction and being wider and deeper as they extend from their origins to their termini.

10. In a pulp refining engine, a plug comprising a frusto-conical abrasive member with a plurality of series of spiral groves in the conical face thereof, the origins of each of the series of grooves being staggered with respect to the origins of each other series, and the grooves of one series having their origins at the top of the truncated cone and extending toward but not to the base of the truncated cone, the said grooves having one side thereof extending in a substantially radial direction and being wider and shallower as they extend from their origins to their termini, and a frusto-conical abrasive shell around said plug and having a plurality of series of diagonal grooves in the conical face thereof, the origins of each of the series of grooves being staggered with respect to the origins of each other series and the grooves of one of said series having their origins at the top of the truncated cone.

11. In a pulp refining engine, a plug comprising a frusto-conical abrasive member with two series of spiral grooves in the conical face thereof, the origins and termini of one series of grooves being staggered with the origins and termini, respectively, of the other series and the said one series being arranged in interdigital relation to the said other series, the origins of the grooves of the said one series being at the top of the truncated cone and the grooves of the said other series having their termini at the base of the truncated cone.

12. In a pulp refining engine, a plug comprising a frusto-conical abrasive member with two series of spiral grooves in the conical face thereof, the origins and termini of one series being staggered longitudinally of the plug with the origins and termini, respectively, of the other series and bearing an interdigital relationship thereto, the grooves of one series having their origins at the top of the truncated cone and extending toward but not to the base of the truncated cone, and the grooves of the other series having their termini at the base of the truncated cone, the leading side of each groove being substantially perpendicular to the axis of the plug and the trailing side of each groove being in acute angular relationship to the leading side.

13. In a pulp refining engine, a plug comprising a frusto-conical abrasive member with two series of spiral grooves in the conical face thereof, the origins and termini of one series being staggered longitudinally of the plug with the origins and termini, respectively, of the other series, the grooves of one series having their origins at the top of the truncated cone and extending toward but not to the base of the truncated cone, and the grooves of the other series having their termini at the base of the truncated cone, the leading side of each groove being substantially perpendicular to the axis of the plug and the trailing side of each groove being in acute angular relationship to the leading side, said acute angular relationship constantly approaching a right angular relationship as the groove extends from its origin toward its terminus.

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