United States Patent [19]

Steiniger

[11] **3,765,611**

[45] **Oct. 16, 1973**

[54] **REFINING PROCESS**

[75] Inventor: **Herman W. Steiniger,** Springfield, Ohio

[73] Assignee: **The Bauer Bros. Co.,** Springfield, Ohio

[22] Filed: **Aug. 7, 1972**

[21] Appl. No.: **278,374**

Related U.S. Application Data

[63] Continuation of Ser. No. 108,882, Jan. 22, 1971, abandoned.

[52] **U.S. Cl.** **241/18,** 241/23, 241/28

[51] **Int. Cl.** **B02c 7/06**

[58] **Field of Search** 241/15, 18, 23, 27, 241/28

[56] **References Cited**

UNITED STATES PATENTS

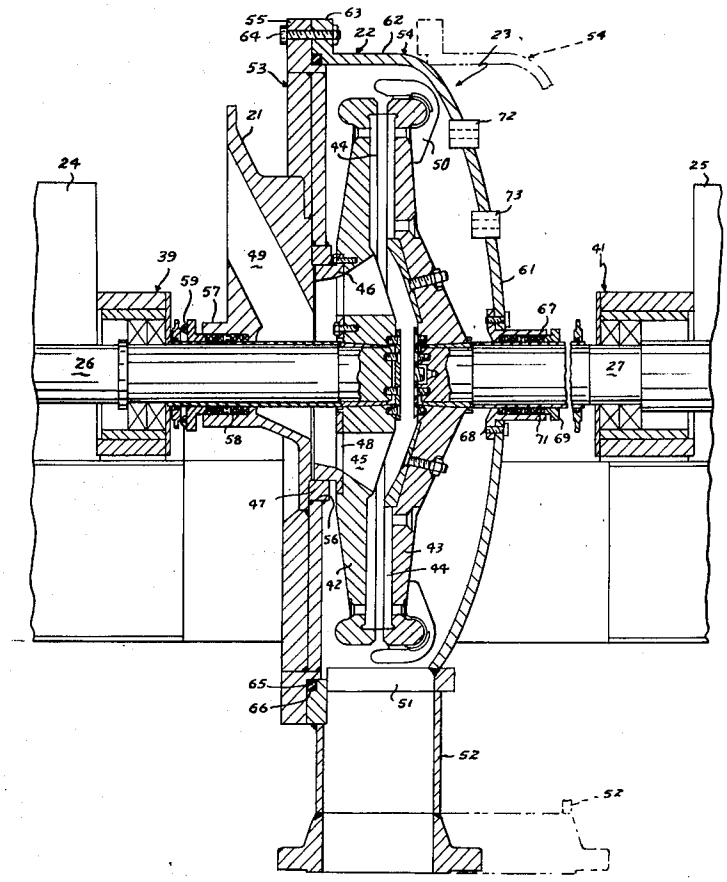
2,561,043	7/1951	Ayers	241/23 X
1,795,603	3/1931	Hussey	241/28 X
2,008,892	7/1935	Asplund	241/18 X
2,035,994	3/1936	Sutherland	241/28 X

Primary Examiner—Granville Y. Custer, Jr.
Attorney—Jerome P. Bloom

[57] **ABSTRACT**

A process of refining pulp type materials utilizing a double revolving disc refiner characterized by introducing said materials into a double revolving disc refiner while maintaining the same under sealed pressurized conditions and subjecting the materials within said refiner to passage between opposed refining surfaces, each of which rotates relative the other with a spacing therebetween not less than about 0.04 inches and from about 0.04 to 0.10 inches, while subjecting said materials to elevated pressures and correspondingly elevated temperatures, and, in movement between said refining surfaces, inducing said materials to form into fiber bundles and individual fibers in a manner to gently produce a separation of the constitutent components of the materials and issue the materials in a form wherein the fibers are relatively long and relatively unscarred.

10 Claims, 4 Drawing Figures



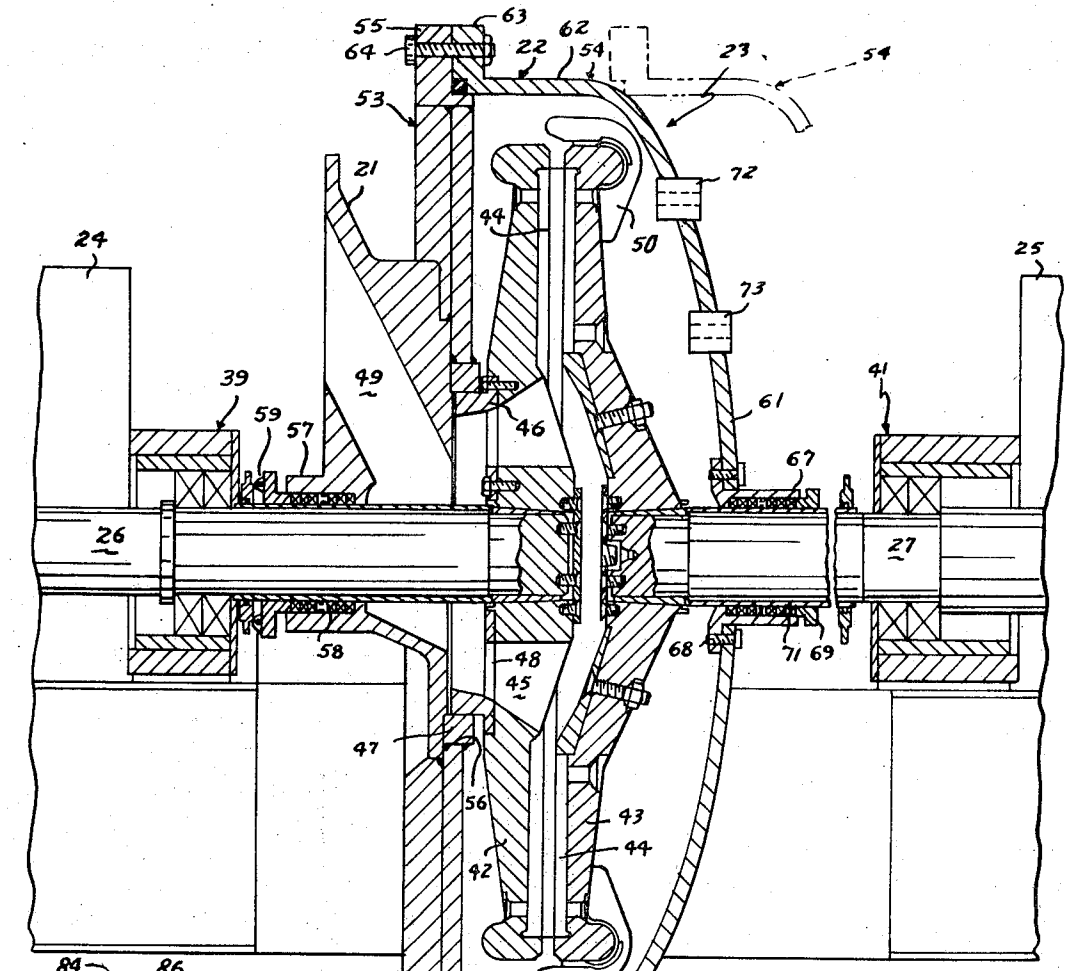


Fig-1

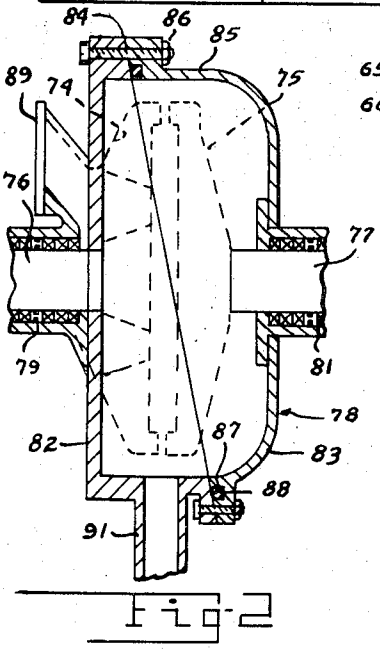


Fig-2

INVENTOR
HERMAN W. STEINIGER

BY Jerome P. Bloom
ATTORNEY

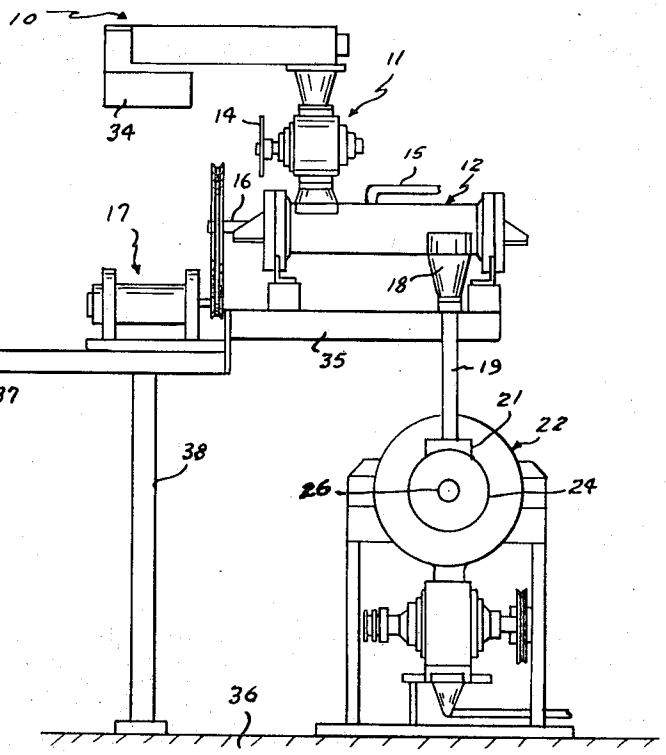


Fig-3

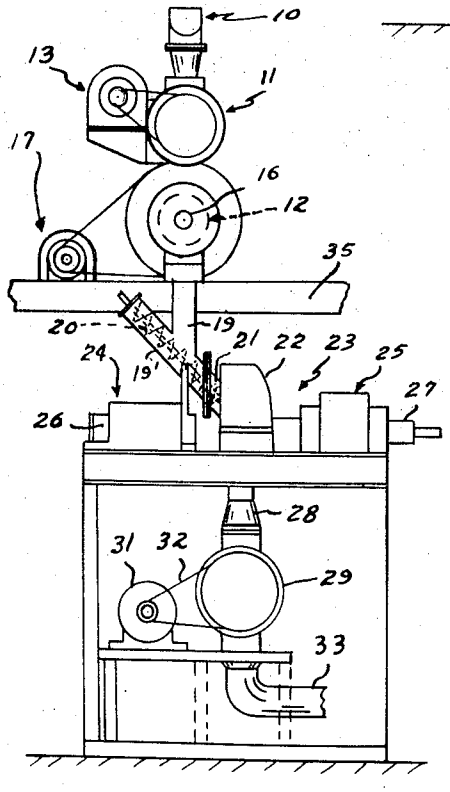


Fig 4

INVENTOR
HERMAN W. STEINIGER

BY Jerome P. Bloom

ATTORNEY

REFINING PROCESS

REFERENCE APPLICATION

This application is a continuation of co-pending application Ser. No. 108,882 filed Jan. 22, 1971 (now abandoned) and correspondingly relates to a division of the invention set forth in applicant's application for U.S. Letters Pat. Ser. No. 495,782 filed Oct. 14, 1965 (now abandoned) for PULP REFINING SYSTEM AND APPARATUS, the latter having been previously co-pending with said application Ser. No. 108,882.

BACKGROUND OF THE INVENTION

This invention relates to double disc refiners and more particularly to improvements in refining processes utilizing such structures to achieve a reduction of materials in a manner to gently separate their basic constituent elements and provide the same in an optimal form. The invention is particularly advantageous in application to the reduction of fibrous materials to individual fibers which are long and strong and will be so described, by way of illustration.

The art of defibering pulp has demanded considerable attention. Various means and methods have been directed to this area of commerce with the ultimate objective of getting longer and stronger fibers. The solutions to date have been compromises. Moreover, the apparatus involved has been not only expensive but the methods of its use have been less than desirable. The present invention is believed to be a simple and effective solution to the problem posed. It is distinguished by the use of a double disc refiner in which relatively opposed discs relatively rotate and which discs are so related as to operate with a particularly advantageous spacing and under conditions of elevated pressure and temperature, the combination of which produces the end results long desired in the art.

A primary object of the invention is to provide improvements in procedures for refining fibrous materials utilizing refiners having opposed relatively rotating discs.

Another object of the invention is to provide a pressurized double disc refining treatment for fibrous pulp in a manner to produce improved individual fibers of optimal length and quality.

An additional object of the invention is to provide a process for refining pulp materials in an environment and under conditions where the individual fibers are separated gently and rapidly in a manner to preclude abrasion and cutting and the resultant fibers are long and of considerable strength.

A further object of the invention is to provide a process of reducing fibrous material to individual fiber form possessing the advantageous features and the inherent meritorious characteristics herein described.

With the above in mind and other incidental objects in view as will more fully appear in the following specification, the invention intended to be protected consists of the process for refining pulp as hereinafter described or illustrated in the accompanying drawings, or the equivalents thereof.

Since the method of the invention can be best illustrated utilizing the most advantageous type structure, in the drawings there is represented the structure which provides an environment typical to the invention process. While there are structural details, obviously the particular structure to be employed is not limited as long as it embodies the capacity of the structure illustrated.

Referring to the drawings,

FIG. **1** is a fragmentary view in longitudinal section, partly diagrammatic, of a pressurized double disc refiner in accordance with the first illustrated form of the invention;

FIG. **2** is a view similar to FIG. **1**, at a reduced scale, showing an alternate form of the invention;

FIG. **3** is a partly diagrammatic view of a pulping system utilizing a refiner in accordance with the instant invention; and

FIG. **4** is the system of FIG. **3** viewed from a position at right angles to that shown in FIG. **3**.

Like parts are indicated by similar characters of reference throughout the several views.

The pulping system of the kind in which this invention may be utilized may comprise a number of treatment or material handling stations. These may include, as shown in FIG. **3**, an open conveyor feeder **10** advancing fibrous material, for example wood chips or plant stock. In a raw, or partly treated condition the fibrous material drops by gravity into a rotary valve unit **11** interposed between the feeder and a digester **12**. The valve device **11** may assume a conventional form, as for example as shown in the patent to Greaves et al., U.S. Pat. No. 2,816,693 dated Dec. 17, 1957. It thus incorporates a rotary valve element providing peripheral cavities conducting material through the valve device under conditions precluding pressure fluid escape thereby. Such rotary element is driven by a motor **13** operating through belt means **14**.

The digester **12** is supplied with steam, as through a pipe **15**, in a manner to maintain the interior thereof under conditions of relatively elevated temperature and pressure. Chemical liquors similarly may be introduced into the digester to assist in the cooking process wherein cohesive substances binding the fibers of the wood chips or plant stock together are softened in a manner to loosen the fibers for subsequent separation. In the illustrated instance the fibrous material is advanced through the digester by suitable feed means operating from a shaft **16** rotatably driven from motor means **17**. The steamed and chemical impregnated fibrous material leaves the digester **12** by way of an outlet duct **18** discharging into a downspout **19**, the latter connecting at its lower end to the inlet chute **21** of a refiner case **22**. The latter provides an enclosure, as will be seen, for double revolving relatively rotating discs comprising the principal operating elements of a refiner **23**.

The downspout **19** has a Y configuration with the lower end connecting to chute **21** and one upper arm connecting to digester **12**. The other upper arm **19'** aligns with chute **21** and may have installed therein a feed screw **20**, externally driven and helping to move materials from digester **12** to inlet chute **21**. Suitable cover means closes the arm **19'** and is constructed to permit passage of the feed screw shaft therethrough.

Further comprised in such refiner are longitudinally spaced apart motors **24** and **25** driving respective shafts **26** and **27** which extend into the case **22**, in a manner to be more specifically described, and mount respective refining discs thereon. The fibrous material passes through the refining station as represented by the refiner **23** and discharges therefrom through a duct **28** to another rotary valve device **29**. This device, operated

by a motor 31 through a belt drive 32, is in the illustrated instance like the valve device 11. It accordingly also incorporates a rotary valve element providing peripheral cavities conducting material through the valve device under conditions precluding pressure fluid escape thereby. Beyond valve device 29 the treated fibrous material is advanced through a duct 33 to a subsequent treatment station, as for example a cyclonic separator. The valve 29 may assume other forms suitable to a controlled discharge of material and steam. For example a Z body valve of Fisher Controls may be substituted for the one shown.

The valves 11 and 29 have the effect of segregating the digester 12 and the refiner 23 from the balance of the system. Accordingly, pressure and temperature conditions established in the digester 12 pervade the segregated area in which the invention is practiced. The case 22 is thus interiorly pressurized by steam from the digester. Supplemental steam may if desired be supplied directly to the case 22. The case 22 is sealed, as will hereinafter more clearly appear, so that the work performed by the refining discs within the case is in a pressurized environment.

Due to the size of the described equipment, and the use made of gravity flow, the different described locations are at different levels, as for example on different floors of the same building. Thus the conveyor feeder 10 is mounted on an uppermost level or floor 34, the digester 12 on a lower level 35 and the refiner 23 on a lowermost floor 36. An intermediate level 37, supporting motor means 17, rests on a support wall 38.

Referring now to FIG. 1, the shafts 26 and 27 of the refiner 23, have what may be termed their inboard ends supported in respective bearing assemblies 39 and 41. The shafts are in an aligned opposing relation and their inner ends are disposed adjacent to one another within the case 22. Secured to the inner end of the shaft 26 is a refining disc 42. In an opposing spaced relation to the disc 42 is a like disc 43 secured to the inner end of shaft 27. In an annular area of each disc working face, near the periphery thereof, is a circumferential series of working plates 44. In another and inwardly spaced annular area of the disc 42 is a circumferential series of feed openings 45. An adapter ring 46 is bolted to what may be considered the rear face of the disc 42 and turns in a bearing ring 47. Openings 48 in the adapter ring 46 are aligned with openings 45 and communicate the latter with an inclined feed passage 49 in the aforementioned chute 21. The passage 49 communicates with the previously described downspout 19 leading from digester 12.

Accordingly, the digester treated fibrous material, along with steam from the digester, is directed by passage 49 to the openings 45 in disc 42 and is directed thereby between the discs 42 and 43.

In the operation of the refiner, the discs revolve in respectively opposite directions and the fibrous material leaving passages 45 is constrained to move radially outward into the area between the discs occupied by plates 44. In accordance with the invention, the plates 44 on the respective discs may be opposite and spaced apart as much as from 0.04 to 0.10 inches, depending on the particular application, preferably between 0.04 and 0.08 for fibrous materials, as here described. In application to waste paper (asphalt dispersion), for example, the spacing may be as much as 0.10 inches. This degree of spacing is contrasted to the usual plate separations of from 0.01 to 0.03 inches proposed per the prior art in use of conventional disc refiners. With and due to the spacing as provided by the invention, as the fibrous material is constrained to move outward on and between opposed plates 44, the plates produce a rapid rolling of fiber bundles and effect a gentle separation of the fibers under the influence of centrifugal force. With the significant spacing the flow of the fiber bundles is fast and the separation into their individual components is just as rapid. The result is enhanced by the fact the widely spaced discs operate in a pressurized environment. An optimal environment will be further described.

In any event, the resultant fibers in the example illustrated will be much longer and stronger than would result in a conventional disc refining operation on the same material.

As a result of the pressure and gravity influences in the refiner 23, the material which is peripherally discharged from between the refiner plates moves to a lower part of the case 22 to an exit or outlet opening 51, communicating through tubular adapter means 52 with the aforementioned valve 29. There are peripherally mounted disc wipers 50 on the disc 43 which propel material issuing from between the discs along the periphery thereof and toward the outlet 51.

Steam pressurization in the double disc mill as provided affords substantial advantages in reference to power consumption and production of the fibers of most desirable quality. The combination of pressure and temperature produced in the refiner weakens the bonding material in wood, for example, to the extent the fibers are easier to separate under the influence of the mechanical action exerted by the plates 44 on the refiner discs. The pressurization in the improved refining process lends ability to the refiner to operate with the opposing sets of plates 44 in an optimally spaced relation. It is noted that the spacing of the plates permit the fibers to be loosened rather than separated by abrasive and cutting action. As will be further described in reference to an optimal pulp refining process in accordance with the invention, the discharge fibers are well formed, relatively unscarred and of good length.

The case 22 of the invention is constructed to sustain selected pressures and temperatures, as for example pressures on the order of 100 lbs. to 150 lbs. per square inch and temperatures of as much as 340° F. It is, moreover, most simply constructed and readily separable into component parts, facilitating the replacement of worn plates 44.

In the refiner of the invention shown in FIG. 1 the case is comprised essentially of two respectively integral parts 53 and 54 which originally, for manufacturing expediency, can be fabricated of multiple elements. In such instance, however, the elements are welded together to form an integrated unit so that the respective parts will here be considered as though made out of a single piece of material. Part 53 has the configuration of a flat planar disc terminating at its periphery in a projected flange 55. In the center of the part 53 is an opening 56 receiving the above mentioned ring 47. Counterbores in the outer surface of the part 53 provide a seat for the discharge end of chute member 21 which may be considered integrated with the part 53. The shaft 26 passes through the chute 21 which is in a closely surrounding relation thereto, and axially through opening 56 to the case interior as before de-

scribed. The chute 21 provides a recessed boss 57 in which is packing means 58 positioning about shaft 26. Retained in place by collar means 59 on the shaft 26, the packing means 58 inhibits a loss of pressure from case 22 along the shaft.

The plate 53 is thus mounted on one side of the pair of rotating discs 42 and 43. On the other side thereof, and in a surrounding relation to the shaft 27, is the second part 54. This part is generally dish shaped in configuration, comprising a plate portion 61 generally parallel to the plate 53 and a longitudinally projected peripheral cup portion 62. The latter extends toward the plate 53 and terminates in an upstanding flange 63 parallel to flange 55. In an assembled or closed position of the parts 53 and 54 the flanges 55 and 63 contact one another and are releasably secured together, as by bolts 64. Further, the projected periphery of part 54 achieves a telescoping relation to the periphery of part 53, and, at the inner portion of the base of flange 55, confines a sealing ring 65. An angular cut-out in the projected periphery of portion 62, at the base of flange 63, defines a groove 66 receiving the sealing ring 65. The arrangement, it will be understood, is one whereby a simple mating of the flanges 55 and 63 and a drawing down of the bolts 64 serves to compress the ring 65, effectively and simply sealing the joint between the parts 53 and 54 against the escape of pressure from the case interior by this route. The shaft 27 passes through a center opening in the part 54 where a cylindrical sleeve 67 is installed. Sleeve 67 is attached to the part 54 by bolts 68 and in conjunction with collar means 69 on the shaft 27 confines packing means 71 sealing against an escape of pressure from the interior of case 22 along such shaft.

The line of separation between the parts 53 and 54, as defined by the point of mating contact between the flanges 55 and 63, accordingly is in a vertical plane to one side of the pair of discs 42 and 43. The outlet 51 from the case 22 is, however, located in the projected periphery 62 of part 54 and is approximately aligned with the line of separation between the discs 42 and 43.

That end of the refiner most adjacent motor 25, bearing assembly 41 and shaft 27 may be termed the control end. It is from this end that shaft 27 may be conventionally adjusted in a longitudinal sense (by means not here shown) to vary the clearance between opposing sets of plates 44. Similarly, it is to this end of the refiner that dish shaped part 54 may be retracted from part 53 to expose the discs 42 and 43 for access thereto. The part 54 normally occupies what may be considered a closed position as illustrated. To achieve an open position of the case, the bolts 64 alone or with bolts 68 are withdrawn and the part 54 shifted rearwardly or in a direction away from part 53. The means utilized for shifting may be manual or otherwise and are not detailed since in and of themselves they form no part of the present invention. Upon return of the part 54 to a closed position the bolts are reinstalled and tightened, the sealing ring 65 is recompressed and the interior of case 22 is again sealed off in this most simple manner.

Insert fittings 72 and 73 are installed in the part 54 for inserting socket wrenches for the installation or removal of plate bolt nuts.

The simplicity of the refiner structure is believed obvious.

An alternate form of the invention shown in FIG. 2 schematically shows discs 74 and 75 corresponding to discs 42 and 43. Shafts 76 and 77 corresponding to shafts 26 and 27 mount the respective discs 74 and 75 within a case 78. Sealing assemblies 79 and 81 are structurally like corresponding assemblies in the FIG. 1 embodiment and similarly inhibit an escape of pressure fluid from within the case 78 along the respective shafts.

The embodiment of FIG. 2, like the embodiment of FIG. 1, provides a case of two part construction which is simply and effectively sealed. In this instance, however, both parts 82 and 83 are generally complementary and dish or cup shaped and have projected peripheries of asymmetrical configuration. Thus, and referring to part 82, the projected periphery 84 thereof has a progressively changing slope between diametrically opposed positions in such manner as to have a maximum projected length in one circumferential area and to have a minimum length in a diametrically opposed circumferential area. The part 83 is complementarily constructed substantially like the part 82 and in the assembly of the case the parts are rotatively positioned to lie in a complementary position to one another. The joint or line of separation between the parts accordingly is on the bias or diagonal, extending in inclined fashion in intersecting relation to the plane of the line of separation between discs 74 and 75. A projecting peripheral portion 85 of the part 83 accordingly is disposed in a diametrically opposed relation to projecting peripheral portion 84 of part 82. The opposed peripheral portions are formed with respective flanges adapted to be drawn into an interfitting or abutting contact by bolts 86. In the abutting, flanged end of peripheral portion 85 is a groove 87 having an O-ring 88 installed therein. Under the clamping pressure applied by tightening of bolts 86 the O-ring 88 is compressed and the joint or line of separation between the parts 74 and 75 of the case effectively is sealed. By loosening the bolts 86 the part 83 may be retracted relatively to the part 82 for access to the discs 74 and 75, in the same manner that part 54 of the FIG. 1 embodiment is retracted. In the instance of FIG. 2, however, both inlet chute 89 and outlet duct 91 are installed in or formed integrally with the part 82. Accordingly, retraction of the part 83 involves no separation of the inlet and outlet fittings which could create problems in recreating the sealed relation of the parts.

The arrangement of the casing is one to place the long portion of projected periphery 84 of part 82, containing outlet 91, in underlying relation to the discs 74 and 75. Correspondingly, therefore, the long portion of projected periphery 85 of part 83 overlies the discs and when withdrawn readily exposes the discs for access to the plates carried thereby.

The foregoing describes, in preferred forms, system and apparatus which may be used in the practice of the process of the invention, particularizing the double disc refiner structure capable of being simply and effectively installed to produce a pressurized refiner unit which may function in a unique manner. Such a unit has been tested and can be pressurized and effectively operate as described with its refiner discs spaced a significant degree more than ever before contemplated in similar type units. It is of course readily obvious that the very simplicity of the refiner case structure and its inherent advantages for effecting and maintaining a seal enhances the advantages of the present invention.

The system in accordance with the invention such as here described enables improved refining processes, particularly in reference to the fibrous pulp-type materials. For example, in processing or defiberizing fibrous pulp material, the invention contemplates a spacing of the refiner plates from 0.04 to 0.08 inches, a pressure in the refiner case, for example, of 100 to 150 p.s.i. and a temperature condition in the range of 320° to 340° Fahrenheit.

With the conditions as described, on introducing fibrous pulp material to the case **22** and movement thereof to flow between the refining discs, the spacing of the refiner plates thereon is such that the pulp is rolled into fiber bundles, the rolling being rapid and producing a gentle separation of the fibers under the influence of centrifugal force created in the counter-rotation of the discs. The separation is facilitated by the temperature and pressure conditions which influence a rapid softening of the bonds between the fibers. The flow through period is rapid. Accordingly, the fibers have a short dwell period in the refiner. The fibers which exit from between the peripheral portions of the opposed refining plates are long and of considerable strength. With the enabling of the wide spacing of the refiner plates one precludes abrasion and cutting which destroys the potential quality of the fibers.

Thus, refining in the double disc refiner under the conditions here specified produces generally improved and highly desirable products. A side effect of this optimum processing of materials as enabled in the pressurized double disc refiner is that the load on the refiner discs during the refiner operation is minimal. The power savings as a result of this condition are significant.

Further, in the particular environment of the invention as above described, and in reference to wood or plant stock, there is shown a preliminary softening of the cohesive substances which bind the fibrous material content. This cooking or conditioning within the pressurized environment preliminary to and in conjunction with the double disc refining therein has proven to facilitate a reduction of time and equipment neccessary to achieve a given fiber product. As a matter of fact even with spacing of less than 0.04 inches between the refiner plates, under conditions noted wherein the environment of the digester and the disc refiner is an elevated temperature up to 340° F. and an elevated pressure, correspondingly, up to 150 p.s.i.g., the result is long, strong fibers of the nature not previously deemed possible. This has been commercially proven. It is pointed out that as late as 1970 an expert in pulping, such as W. J. Nolan, stated in the "Handbook of Pulp and Paper Technology" that ideal mechanical subdivision of wood to produce a comparatively undamaged cellulose fiber containing **4** to 5 percent lignin "is obviously impossible." Yet double revolving disc refining under pressurized conditions in accordance with the present invention has in fact achieved what has been deemed impossible. That the prior art has been obviously incapable of this "impossible" result is self-evident from the testimony of an expert.

From the above description it will be apparent there is thus provided a process of the character described possessing the particular features of advantage above enumerated and inherently susceptible of modification within the framework of the invention without departing from the principle involved or sacrificing any of its advantages. Such modifications are deemed to be contemplated within the scope of the present invention and the invention is therefore claimed in any of its applications and modifications within the legitimate and valid scope of the appended claims.

Having thus described my invention, I claim:

1. A method of refining fibrous materials comprising the steps of introducing the materials into a refiner casing while maintaining the same in a sealed pressurized condition, within said casing flowing said materials between a pair of relatively opposed refining surfaces while maintaining a spacing between said refining surfaces a distance not less than about 0.04 inches, inducing said refining surfaces to rotate one relative to the other and to operate on said material while maintaining thereon an elevated pressure and correspondingly elevated temperature, and reducing said materials between said opposed refining surfaces to fiber bundles and to individual fibers, maintaining and extracting the individual fiber content in a relatively unscarred and individually relatively long and well formed condition, in which condition they are issued from the sealed environment of said casing.

2. A method of refining fibrous materials according to claim **1** characterized by maintaining said refining surfaces with a spacing therebetween from about 0.04 to 0.10 inches while particles of said materials are induced to flow between said refining surfaces for reduction thereof to fiber form.

3. A method of refining fibrous materials as set forth in claim **1** characterized by limiting the space between said refining surfaces to a distance from approximately 0.04 to 0.08 inches during the operation thereof on said materials in particle form to reduce the same to their fiber content.

4. A method of refining fibrous materials as set forth in claim **1** characterized by maintaining on said materials during the passage thereof between said refining surfaces a pressure not less than about 100 p.s.i.g. and a correspondingly elevated temperature.

5. A method of refining fibrous materials as set forth in claim **1** characterized by subjecting said materials in particle form to a temperature not lower than about 320° F. during passage thereof between said refining surfaces.

6. A method of refining fibrous materials as set forth in claim **1** characterized by introducing said materials in particle form and maintaining a pressure on said particles in the range of 100 to 150 p.s.i.g. while passing the same between said refining surfaces and during passage of the particles between said refining surfaces maintaining said refining surfaces spaced apart a distance from 0.04 to 0.10 inches.

7. The method of refining fibrous materials according to claim **1** characterized by a further step of applying a conditioning medium directly to said materials within the same pressurized environment as that to which said materials are subjected in movement between said refining surfaces.

8. The method of refining fibrous materials according to claim **7** characterized by applying said conditioning medium on said materials in transit to said refining surfaces.

9. The method of refining fibrous materials according to claim **7** characterized by applying said conditioning medium to said materials in transit to said refining cas-

ing and in a vessel in open and direct communication with said refiner casing.

10. A method of refining fibrous materials, including the step of providing a sealed environment therefor wherein means define a flow path for said materials to move directly through said environment, providing for certain material to enter said flow path under conditions precluding communication of said environment with ambient surroundings and to leave said flow path under like conditions, within said environment passing said material in said path between opposed refining surfaces, each of which is rotated, one relative to the other, maintaining a relatively wide spacing between said refining surfaces in the range of 0.04 to 0.10 inches so that the flow of the fibrous material therebetween is relatively free and rapid, in a single pass of said material between said refining surfaces converting the same to a condition distinguished by relatively long and relatively unscarred fiber elements, and pressurizing said environment by admitting pressure fluid to said path to provide that the fibrous material flows to and between said surfaces in a pressurized condition and subjecting said materials to a digesting action immediately prior to their passage between said refining surfaces and in an environment wherein the conditions are common to the environment within which said refining surfaces operate.

* * * * *