Nov. 19, 1968 R. L. BUCHBERGER ETAL 3,411,986

AXIAL FLOW ROTARY FEEDER FOR CELLULOSE DIGESTER

Filed Aug. 4, 1965 3 Sheets-Sheet 1

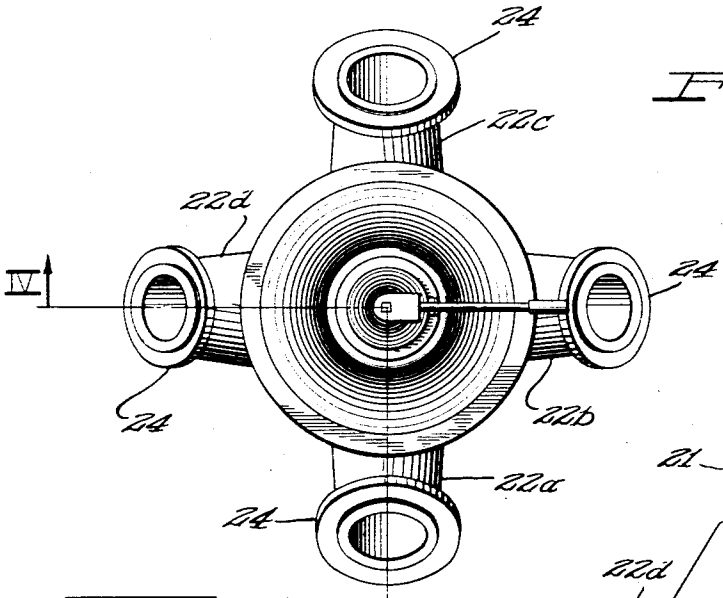


Fig. 3

Fig. 1

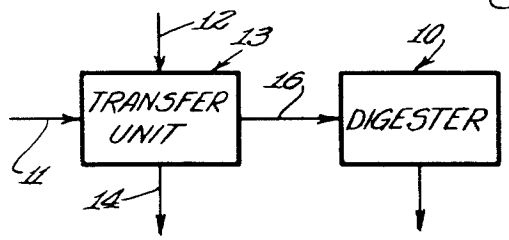
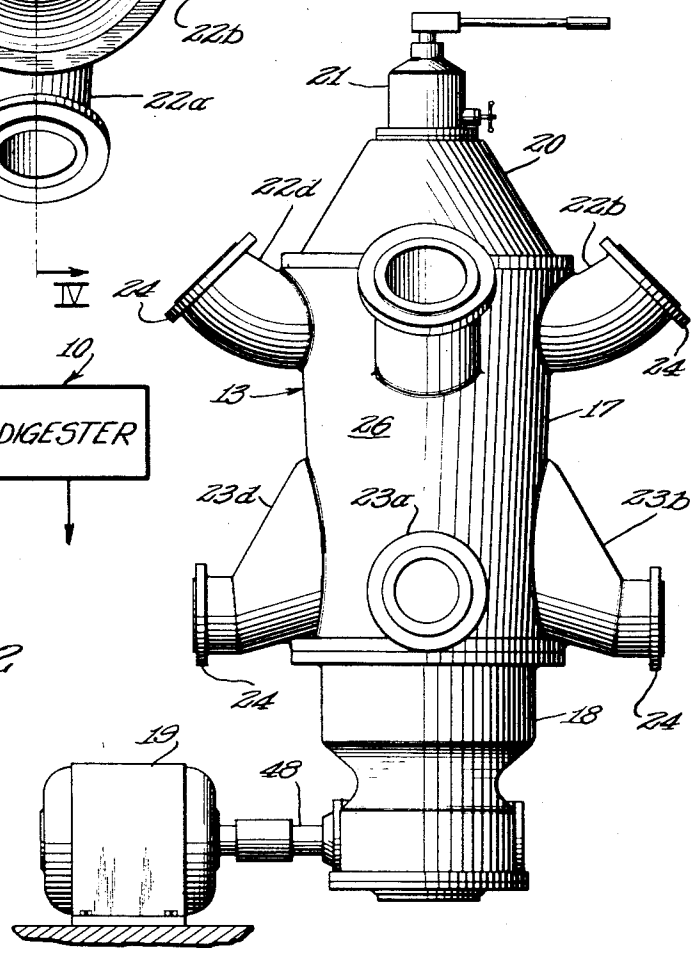


Fig. 2



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AXIAL FLOW ROTARY FEEDER FOR CELLULOSE DIGESTER

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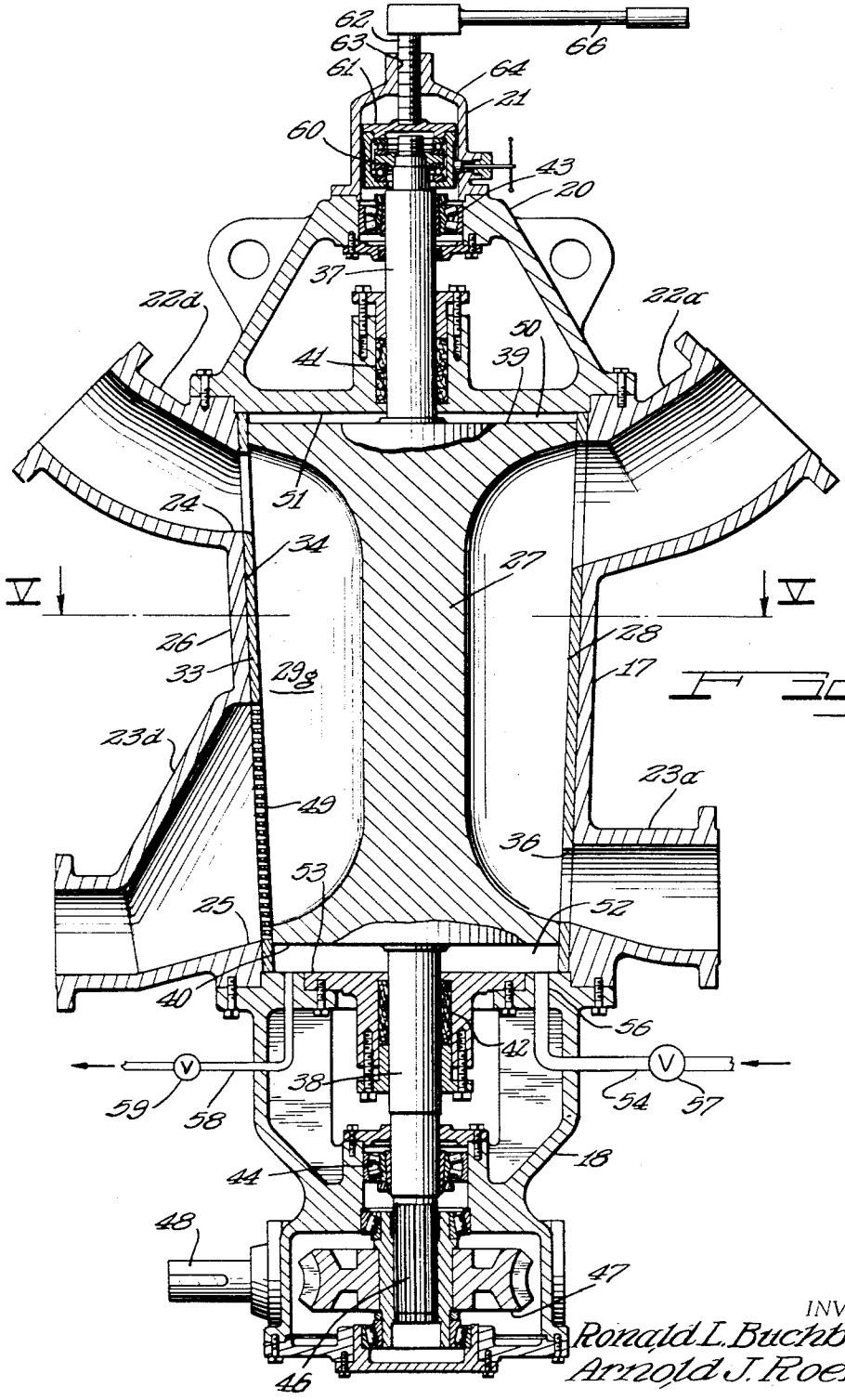

Fig. 4

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Fig. 5

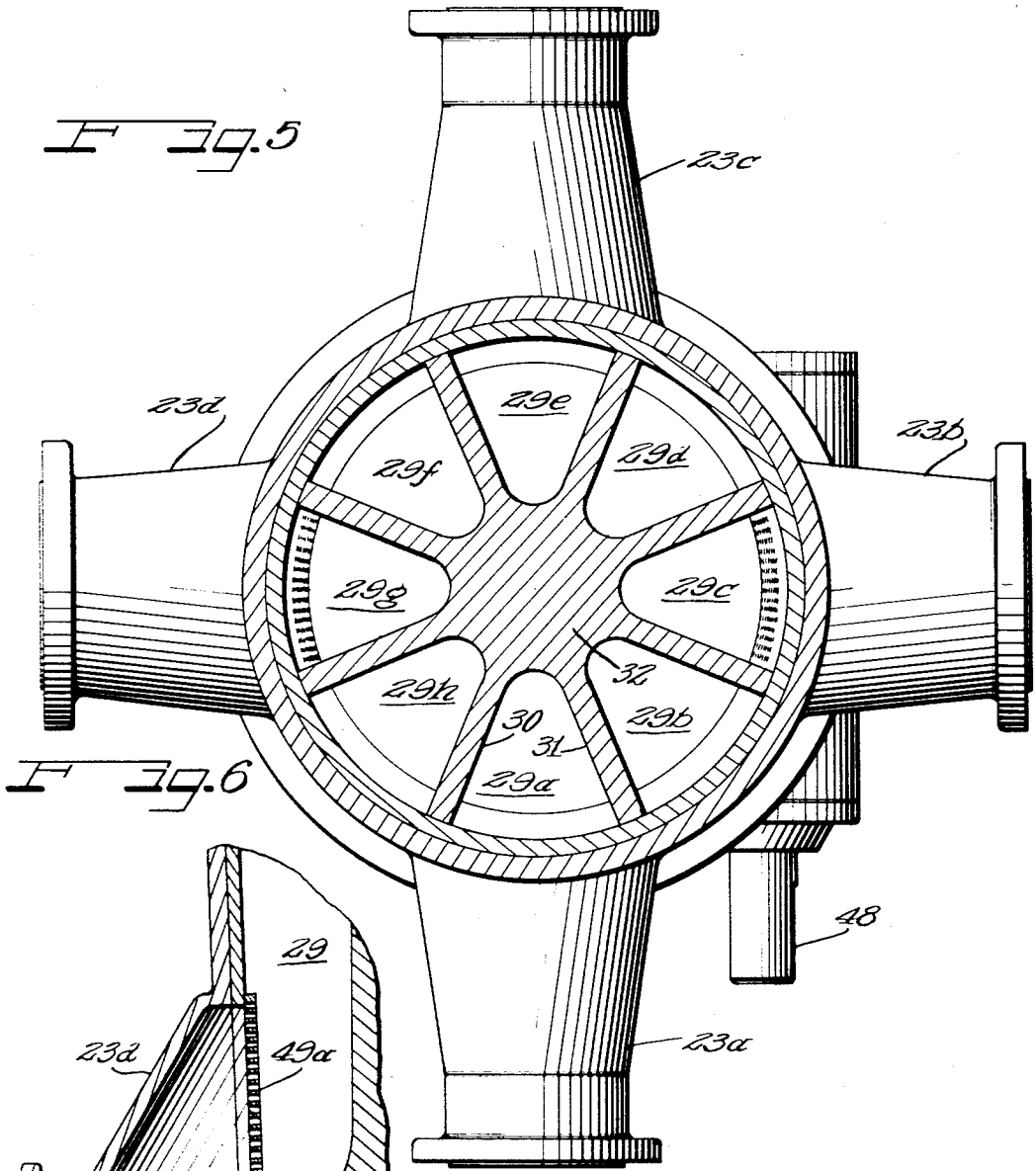

Fig. 6

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AXIAL FLOW ROTARY FEEDER FOR CELLULOSE DIGESTER

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4 Claims. (Cl. 162—246)

ABSTRACT OF THE DISCLOSURE

Apparatus for feeding cellulosic material to a continuous pulping digester. The apparatus is a rotary feeder valve having a frusto-conically shaped bore with at least two pairs of inlets and outlets therein and a complementarily shaped rotor in the bore with passages in the rotor. The passages are arranged to interconnect first one of the said pairs of inlets and outlets and then the other pair upon rotation of the rotor and screens are placed in either the rotor or the outlets in the bore for collecting chips in the passages.

This invention relates generally to pulp and papermaking apparatus and more particularly to apparatus for transferring and feeding wood chips during a continuous pulping process.

Advances have been made in the development of continuous pulping processes and there are now a number of soundly developed systems for continuous pulping, particularly of the chemical and semi-chemical types. Continuous pulping can afford many advantages over a batch operation, among which are reduced time requirements, a more uniform product, utilization of better control methods, greater flexibility and the ability to use lower liquor ratios.

Continuous pulping processes are often complicated, however, and have presented problems of mechanical design. For example, in some operations such as in feeding wood chips to the digesters or in transferring the wood chips from one digester to another the chips may desirably be first carried in one fluid medium such as a first liquor and then transferred to another fluid medium such as a second liquor which might be at a different pressure, temperature, etc., than the first liquor.

The present invention is addressed to such problems and provides means not only for effecting such transfer but for accomplishing the transfer continuously as required in feeding wood chips in a continuous pulping process.

The feeding or transfer apparatus of the present invention is simple in design, relatively inexpensive in manufacture, provides a high transfer or feeding capacity, is easy to operate, can be controlled automatically, is rugged in construction and can serve a long, useful life.

It is, therefore, an object of the present invention to provide means for transferring wood chips from a first liquor to a second liquor, the two liquors having different conditions of pressure or temperature or the like.

Another object of the invention is to provide a digesting system for a continuous pulping process including means for continuously delivering wood chips to the digester for processing.

Another object of the invention is to provide a rotary feeder for a digester system incorporating a stationary stator and a rotatable rotor and including means for reducing wear between the stator and the rotor.

A further object of the invention is to provide, in a vertical feeder having a rotor rotatable within the bore of a stationary stator, a pressurized chamber within the bore to counterbalance the weight of the stator to reduce wear.

Yet another object of the invention is to provide a feeder for a digester system in a continuous pulping process whereby wood chips are continuously transferred from a first liquor to a second liquor for delivery to a digester, and in which only one moving part is required in the feeder.

Still another object of the invention is to provide a feeder or transfer mechanism which is simple in design, relatively inexpensive in manufacture, provides a high transfer capacity, is easy to operate, is rugged in construction, and can serve a long, useful life.

Many other features, advantages and additional objects of the present invention will become manifest to those versed in the art upon making reference to the detailed description which follows and the accompanying sheets of drawings, in which preferred structural embodiments incorporating the principles of the present invention are shown by way of illustrative example only.

In the drawings

FIGURE 1 is a schematic plumbing diagram of a continuous digesting system incorporating the principles of the present invention;

FIGURE 2 is a side elevational view of a transfer or feeder unit constructed in accordance with the principles of the present invention;

FIGURE 3 is a top plan view of the feeder unit of FIGURE 2;

FIGURE 4 is a sectional side view of the feeder unit taken along lines IV—IV of FIGURE 3;

FIGURE 5 is a horizontal sectional view of the feeder unit taken along lines V—V of FIGURE 4; and

FIGURE 6 is a fragmentary vertical sectional view of the feeder illustrating another embodiment of a screening means thereof.

As shown in the drawings

Although the principles of the present invention are applicable in any system wherein solids are to be transferred from one fluid medium to another, a particularly useful application is made to a pulping process in the manufacture of stock for making paper products wherein wood chips are treated mechanically and/or chemically at a plurality of treatment stations or zones and may be transferred from one treatment zone to another in one or more liquor mediums, as will be understood by those skilled in the art.

The present invention is also particularly useful where the transfer of the solids is essentially a continuous process. For example, generally in a pulping process the wood chips are subjected to certain treatment before entering the digesters. In a batch operation, the chips are moved periodically from one treatment station or zone to another, and then delivered to the digester or digesters in a slug or batch. As noted hereinabove, a batch operation is not generally as desirable as a continuous process wherein the chips are continuously moved through the various treatment zones and into and through the digesters.

A continuous pulping process, however, raises certain problems, not the least of which involves the continuous transfer of the chips from one fluid medium to another through the various treatment zones and into the digesters.

The present invention provides improved means for effecting such transfer and for continuously moving the chips through the various treatment zones and into the digesters.

Referring to FIGURE 1, a typical digester is indicated generally at reference numeral **10**. Usually the digester receives the chips after they have been worked on in other treatment zones.

For example, in some pulping processes the chips are delivered from a chipper or a grinder in a first liquor

medium to a first treatment zone. The particular liquor utilized is generally necessary for the proper treatment of the chips and after this phase of the process is completed the chips may be moved to a second treatment zone. The second treatment may require a second liquor, which may be chemically different from the first liquor or may differ only in temperature or pressure. In any event, it may not be the same liquor or may not be maintained under the same conditions as the first liquor, and therefore the chips are transferred from the first to the second liquor. In so doing the two treatment zones should remain isolated from one another so that a higher pressure or temperature of the liquor of one will not be reduced to that of the other.

In FIGURE 1 it will be assumed that the treatment involved in the digester **10** requires a high pressure liquor and that the next preceding treatment station utilizes a liquor similar to the liquor used in the digester process, but maintained at a lower pressure. It will be understood, however, that the difference between the two liquors could be temperature rather than pressure, or temperature and pressure, or the two liquors could differ chemically. However, for one or more of these reasons it is assumed that it is desirable to keep the two liquors separated, or at least substantially so.

Reference numeral **11** denotes a conduit for conveying a flow of low pressure liquor having wood chips suspended therein from a treatment zone which next precedes the digester **10** in a pulping process. Assume that the digester **10** utilizes a high pressure liquor which is conveyed by a conduit **12** and which flows in the direction indicated from a source thereof. The wood chips being carried in the low pressure liquor in conduit **11** are to be transferred to the high pressure liquor flowing in conduit **12**, and for that purpose the respective conduits are connected to a feeder or transfer unit indicated generally at **13** which is constructed in accordance with the principles of the present invention.

Reference numeral **14** denotes a conduit carrying the low pressure liquor after it has passed through the feeder unit **13** and after the wood chips have been removed therefrom and transferred to the high pressure liquor. Reference numeral **16** denotes a conduit carrying the high pressure liquor after it has passed through the feeder **13** and after the chips have been transferred thereto, and this conduit is connected to the digester **10** for feeding the digester with a supply of treated chips.

Referring to FIGURES 2 and 3, the feeder unit **13** is more particularly characterized as comprising a generally cylindrically shaped vertically upstanding stator portion **17**, a drive portion **18** at the lower end of the stator and having suitable drive means such as an electric motor **19**, connected thereto, and a top portion **20** situated at the upper end of the stator and having mounted thereon a bearing assembly indicated generally at reference numeral **21**.

A plurality of conduit connectors extend from the stator **17** and are adapted for connection to the various conduits which receive and deliver the liquor and wood chips transferred to and from the feeder **13**.

For example, in the illustrated embodiment of the feeder **13** four connectors indicated respectively at reference numerals 22_a–22_d are connected in fixed assembly by suitable means such as a weld connection or the like to the upper portion of the body or stator **17** and are spaced circumferentially 90° around the periphery of the stator. At the lower end of the stator another group of four connectors indicated at 23_a–23_d are also mounted on the stator in vertical alignment with connectors 22_a–22_d. Each of the connectors includes a flange **24** for connection to the various conduits **11**, **12**, **14** and **16** although it will be understood that where two or more of the connectors are connected to a single conduit suitable means such as a header may be utilized in making the connection.

Referring to FIGURES 4 and 5 it will be noted that all of the connectors are in open communication with the interior of the body or stator portion **17** through a plurality of complementarily aligned openings as indicated at **25** formed in a longitudinal wall **26** of the stator **17**.

Rotatably carried within the stator **17** is a generally cylindrically shaped rotor **27** having formed therein a plurality of axially extending passages which in the embodiment illustrated are constructed as recesses formed in a peripheral wall **28** of the rotor **27**. The passages are eight in number indicated respectively at reference characters 29_a–29_h and are spaced circumferentially equidistantly around the periphery of the rotor. Each of the passages is separated from adjacent passages by means of a pair of diverging walls **30** and **31** which extend radially outwardly from a center or hub portion **32** of the rotor.

Also housed within the stator **17** is a tubular liner **33** which is shaped complementarily to an inner surface **34** of the stator wall **26** and the peripheral surface **28** of the rotor **27**. The liner **33** also has formed therein a plurality of complementarily aligned openings as at **36** to afford open communication of the connectors with the interior of the stator **17**.

A pair of coaxial shafts **37** and **38** extend from opposite end walls **39** and **40** of the rotor **27**, shaft **37** extending upwardly into the top portion **20** of the feeder and shaft **38** extending vertically downwardly into the drive portion **18**. Suitable packing members **41** and **42** are provided on the respective shafts **37** and **38** for preventing excessive leakage therepast. A pair of radial thrust bearings **43** and **44** are mounted respectively in the top portion **20** and the drive portion **18** for journalling shafts **37** and **38** and in order to rotate the rotor **27** a lower end **46** of the shaft **28** is splined for driving connection with a gear **47** which is in meshing engagement with a worm gear co-rotatably connected to a drive shaft **48** driven by the motor **19** (FIGURE 2).

In order to explain the operation of the feeder **13** assume that connectors 22_b and 22_d are connected by suitable header means to conduit **11** which is, in turn, connected to the source of a first liquor and chips, and connectors 23_b and 23_d, which are spaced axially from connectors 22_b and 22_d, are connected by suitable header means to conduit **14** for carrying away the first or low pressure liquor from the feeder after the chips have been removed therefrom. Connectors 22_a and 22_c are connected by conduit **12** to the second or high pressure liquor to which the chips are to be transferred and connectors 23_a and 23_c are connected to the conduit **16** for delivering the second liquor and chips to the digester **10**. It will be appreciated, however, that connectors 22_a and 22_c could be connected to conduit **16** and connectors 23_a and 23_c to conduit **12** for reverse flow of the second liquor through the feeder **13**.

As the rotor **27** is turned by the drive mechanism each of the passages 29_a–29_h will sequentially interconnect in fluid communication first connectors 22_d and 23_d (likewise 22_b and 23_b) and then connectors 22_a and 23_a (likewise 22_c and 23_c).

For example, in FIGURE 4 the passage 29_g is situated so as to communicate connector 22_d with connector 23_d. The first liquor and chips thereby flow from connector 22_d into the passage 29_g, wherein the chips are retained by means of a screen **49** formed in the liner **33** across the opening of the connector 23_d.

Upon continued rotation of the rotor **27** (approximately 90° for the embodiment illustrated) the passage 29_g with the chips collected therein will communicate connectors 22_a and 23_a, whereupon the chips will be flushed from the passage to be delivered with the second liquor to the digester.

It will be appreciated that as a result of the arrangement of the passages 29_a–29_h, a quantity of chips are con-

tinuously collected in two of the passages and are continuously flushed from two different passages, as a result of which the transfer of the chips from the first to the second liquor and the delivery of the second liquor and chips to the digester is a substantially continuous operation.

It may be desirable for the screen means to be formed directly on the rotor **27** rather than in the liner **49** (which is effectively the body wall **26**). Referring to FIGURE 6, in an alternative arrangement a screen member 49_a shaped complementarily to the curvature of the liner **26** is mounted at the lower end of a typical passage **29** for collecting the chips in the passage. It will be appreciated that in this arrangement a screen member 49_a is required for each of the passages 29_a–29_h, and furthermore it will be appreciated that the second liquor must be "back-flushed" through the rotor to flush the chips therefrom. In FIGURE 4, for example, if a plurality of screen members 49_a were mounted respectively at the lower end of each of the passages 29_a–29_h, the conduit **12** (FIGURE 1) would be connected to the connector 23_a rather than 22_a and conduit **16** would be connected to connector 22_a, whereby the second liquor would back flush the chips off of the screen members 49_a and out of the passages as the respective passages interconnected connectors 23_a and 22_a.

In order to provide a good sealing or substantially leak-proof relation between the engaging faces of the rotor **27** and the liner **33**, in the illustrated embodiment the wall **26** of the stator **17**, the liner **33** and the peripheral wall **28** of the rotor **27** are frusto-conically shaped and taper inwardly at the lower end thereof. A gap or space **50** is provided between the top end wall **39** of the rotor **27** and a radial face or end plate **51** of the top portion **20**. A relatively larger space or chamber **52** is provided between the lower end wall **40** of the rotor **27** and a radial end plate **53** of the drive portion **18**. As a consequence thereof the rotor **27** is movable axially within the stator **17** within the limits defined by the end plates **51** and **53**.

In order to counterbalance the weight of the rotor **27** and the axial forces acting on the rotor as a result of the flow of liquor therethrough, and also to reduce wear between the engaging faces of the rotor **27** and the liner **33**, a conduit **54** is connected at one end **56** thereof to the lower chamber **52**, and at the other end thereof to a suitable source of pressurized fluid. A pressure regulator valve **57** is mounted in conduit **54** in order to regulate the pressure of chamber **52** and to thereby control the counterbalancing effect on the rotor **27**.

Any pressurized fluid may be utilized for this purpose. If steam is available an additional conduit **58** may also be connected to chamber **52** for removing condensate from the chamber and a steam trap or condensate valve **59** may preferably be mounted in the conduit **58** as will be understood by those skilled in the art.

In order to accommodate axial thrust of the rotor **27** as a result of the pressurization of chamber **52**, an axial thrust bearing **60** is mounted at the upper end of shaft **37** and is restricted in upward movement thereof by a collar **61** and the axial thrust bearing **60**, a handle **66** is mounted may be adjusted vertically by means of a threaded stud **62** connected to the collar **61** and received in a complementarily threaded bore **63** formed in a cover **64** of the bearing assembly **21**. In order to facilitate rotation of the stud **62** and consequently vertical adjustment of the collar **61** and the axial thrust bearing **60**, a handle **66** is mounted at the upper end of the stud **62**.

As a result of the axial adjustability of the thrust bearing **60**, the lower chamber **52** may be pressurized to a relatively high pressure but the rotor **27** will be limited in axial movement to provide for minimum wear between the engaging faces of the rotor **27** and the liner **33** while also maintaining a substantially leak-proof relationship therebetween.

With respect to radial thrust forces acting on the rotor **27** it will be noted that as a result of the diametrically opposite arrangement of the connectors 22_b and 22_d, both of which are connected to the first liquor, the diametrically opposite arrangement of the connectors 22_a and 22_c, which are spaced circumferentially 90° with respect to connectors 22_b and 22_d and both of which are connected to the second liquor, and the diametrically opposite arrangement of the corresponding connectors 23_a–23_d, the radial thrust forces acting on the rotor **27** are completely balanced, regardless of the angular disposition of the rotor during rotation thereof.

Although in the embodiment illustrated the lower connectors 23_a–23_d are in vertical alignment with the connectors 22_a–22_d, it will be appreciated that the upper and lower connectors may be somewhat circumferentially offset with respect to one another while maintaining a 90° circumferential spacing between the connectors 22_a–22_d and between connectors 23_a–23_d to maintain a balanced radial thrust condition on the rotor **27**. Such arrangement, of course, would necessitate a corresponding "helical" construction of the passages 29_a–29_h in the event that the degree of offset between the axially spaced upper and lower connectors required such modification.

Although these and other minor modifications might be suggested by those versed in the art, it should be understood that we wish to embody within the scope of the patent warranted hereon all such modifications as reasonably come within the scope of our contribution to the art.

We claim as our invention:

1. In a digester system for digesting wood chips,

a rotary feeder for liquor and chips comprising a stator having means forming a vertically extending frusto-conically shaped bore therein, means forming at least two pairs of openings in said stator each of which pairs comprises an inlet and an outlet,

a complementarily shaped rotor rotatably carried in said bore and having means forming a plurality of passages therein,

said passages each being arranged to successively interconnect first one of said pairs of said openings and then another of said pairs upon rotation of said rotor,

screen means between said one pair of said openings for collecting chips in said passages as each passage interconnects said one pair of said openings,

means for rotating said rotor in said stator,

bearing means for journalling said rotor in said stator and for accommodating axial thrust, and

means for moving said bearing means axially to provide axial movement of said rotor in said stator.

2. In a digester system for digesting wood chips,

a rotary feeder for liquor and chips comprising a stator having means forming a vertically extending frusto-conically shaped bore therein with the larger diameter end of said bore situated at the upper end thereof,

means forming at least two pairs of openings in said stator each of which pairs comprises an inlet and an outlet,

a complementarily shaped rotor rotatably carried in said bore and having means forming a plurality of passages therein,

said passages each being arranged to successively interconnect first one of said pairs of said openings and then another of said pairs upon rotation of said rotor,

the length of said rotor being less than the length of said bore to provide a chamber therebetween at the lower end thereof,

screen means between said one pair of said openings for collecting chips in said passages as each passage interconnects said one pair of said openings,

means for rotating said rotor in said stator, and

conduit means for introducing a pressurized fluid into said chamber to counterbalance the effective weight of said rotor and to reduce wear between said rotor and the wall of said bore.

3. In a digester system for digesting wood chips,

a rotary feeder for liquor and chips comprising a stator having means forming a vertically extending frustoconically shaped bore therein with the larger diameter end of said bore situated at the upper end thereof,

means forming at least two pairs of openings in said stator each of which pairs comprises an inlet and an outlet,

a complementarily shaped rotor rotatably carried in said bore and having means forming a plurality of passages therein,

said passages each being arranged to successively interconect first one of said pairs of said openings and then another of said pairs upon rotation of said rotor,

the length of said rotor being less than the length of said bore to provide a chamber therebetween at the lower end thereof,

screen means between said one pair of said openings for collecting chips in said passages as each passage interconects said one pair of said openings,

means for rotating said rotor in said stator,

conduit means for introducing a pressurized fluid into said chamber to counterbalance the effective weight of said rotor and to reduce wear between said rotor and the wall of said bore, and

valve means in said conduit means for controlling the pressure of the fluid in said chamber.

4. In a digester system for digesting wood chips,

a rotary feeder for liquor and chips comprising a stator

having means forming a vertically extending frustoconically shaped bore therein,

means forming at least two pairs of openings in said stator each of which pairs comprises an inlet and an outlet,

a complementarily shaped rotor rotatably carried in said bore and having means forming a plurality of passages therein.

said passages each being arranged to successively interconnect first one of said pairs of said openings and then another of said pairs upon rotation of said rotor, the length of said rotor being less than the length of said bore to provide a chamber therebetween at one end of the bore,

screen means between said one pair of said openings for collecting chips in said passages as each passage interconects said one pair of said openings,

means for rotating said rotor in said stator,

axially adjustable bearing means for journalling said rotor in said stator and for accommodating axial thrust,

conduit means for introducing a pressurized fluid into said chamber, and

valve means in said conduit means for controlling the pressure of the fluid in said chamber in order to control the axial thrust on said bearing means.

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