Oct. 28, 1958 L. G. DURANT ET AL 2,858,212

WOOD CHIP FEEDERS

Filed Feb. 13, 1956

3 Sheets-Sheet 1

FIG. 2.

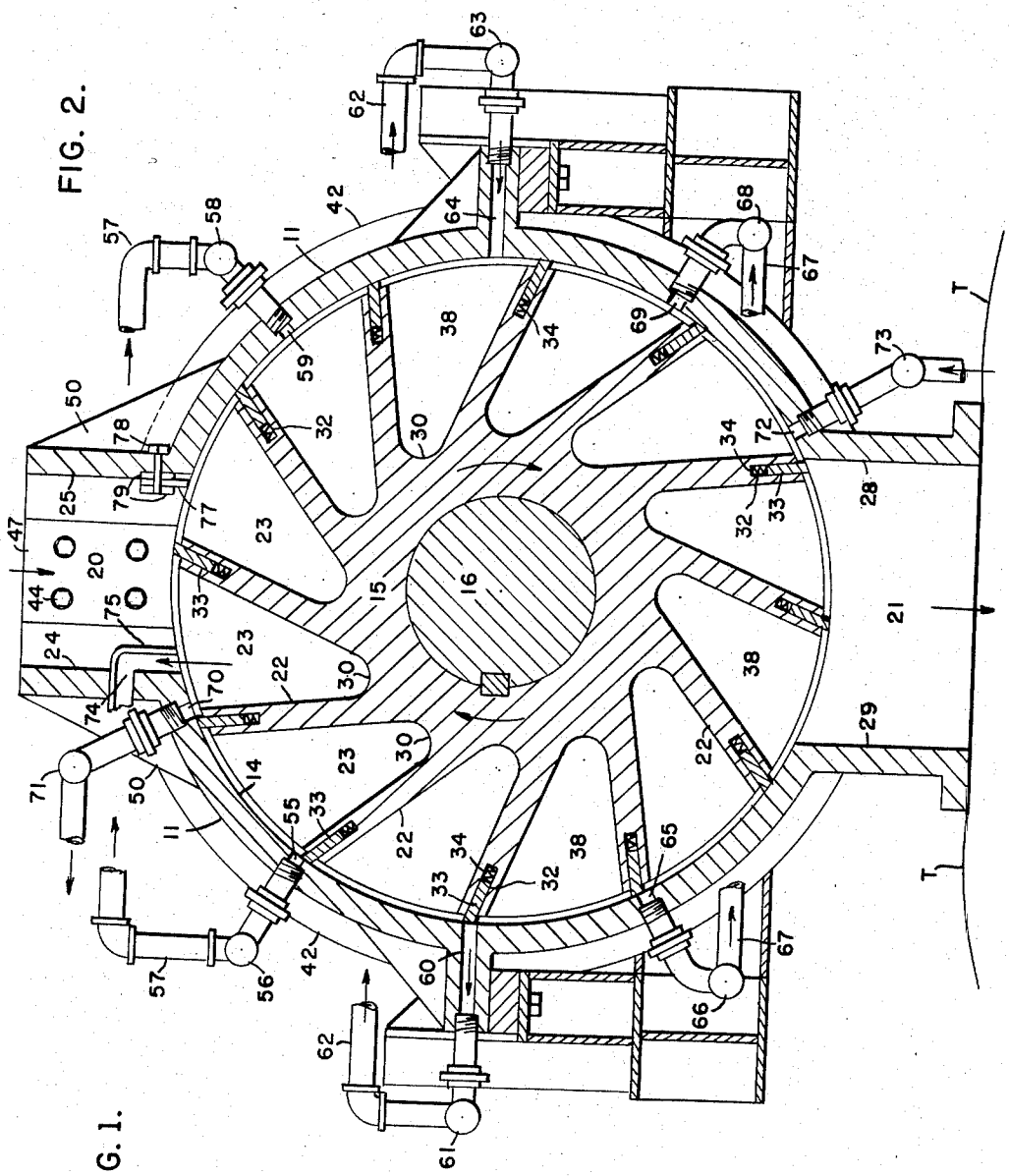
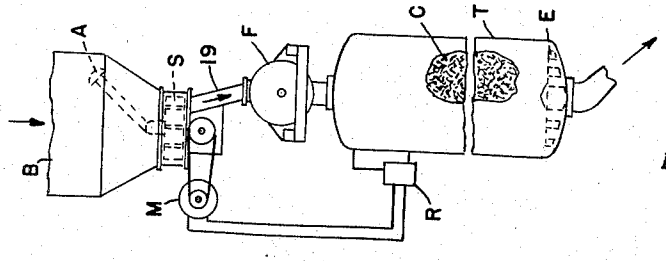


FIG. 1.



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FIG. 3.

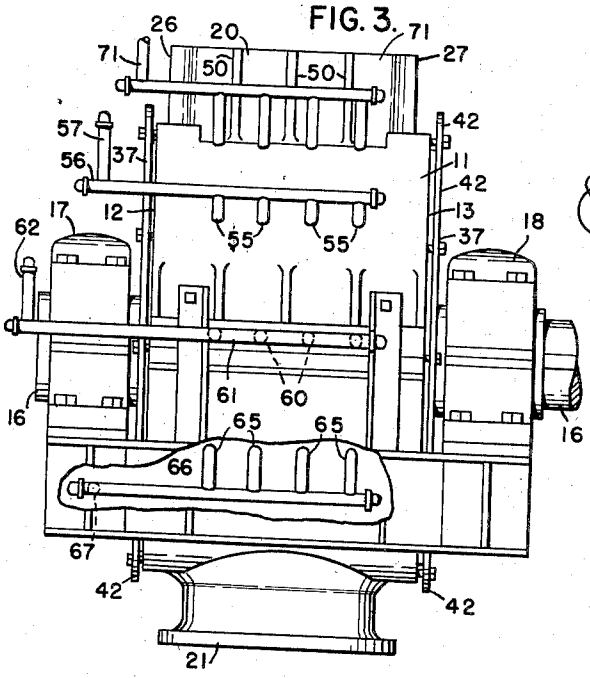


FIG. 5.

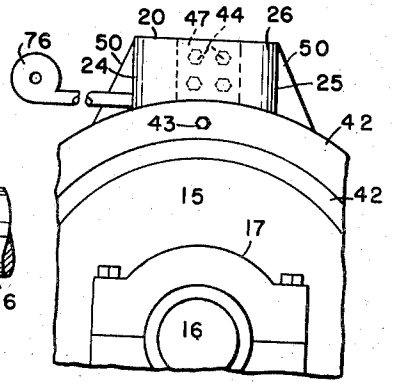


FIG. 4.

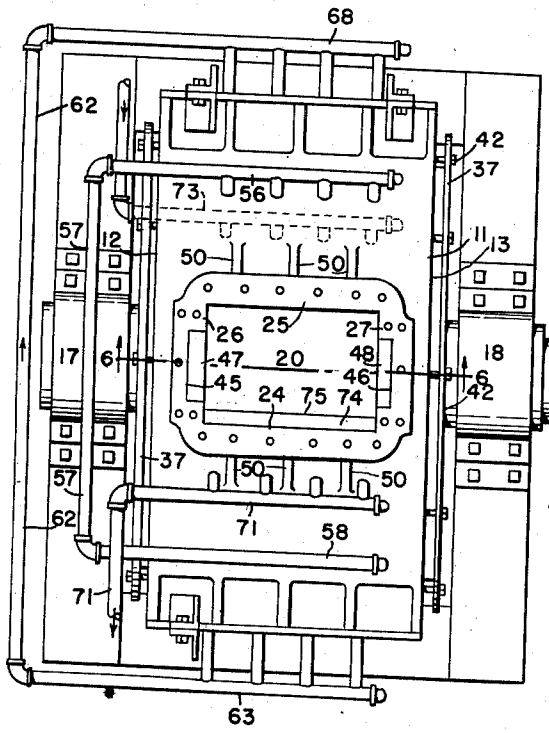
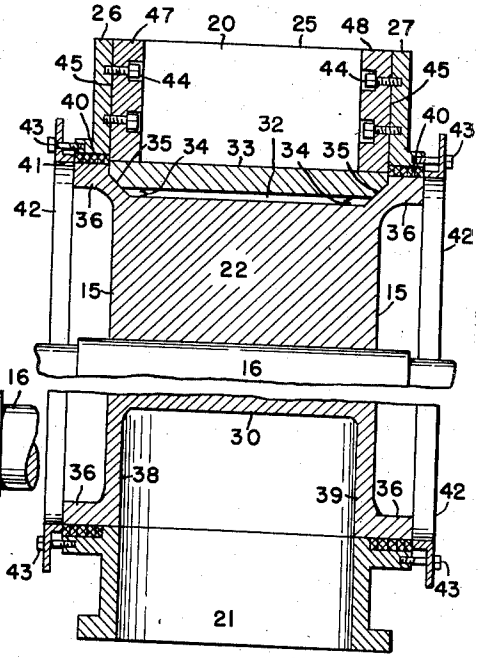


FIG. 6.



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FIG. 9.

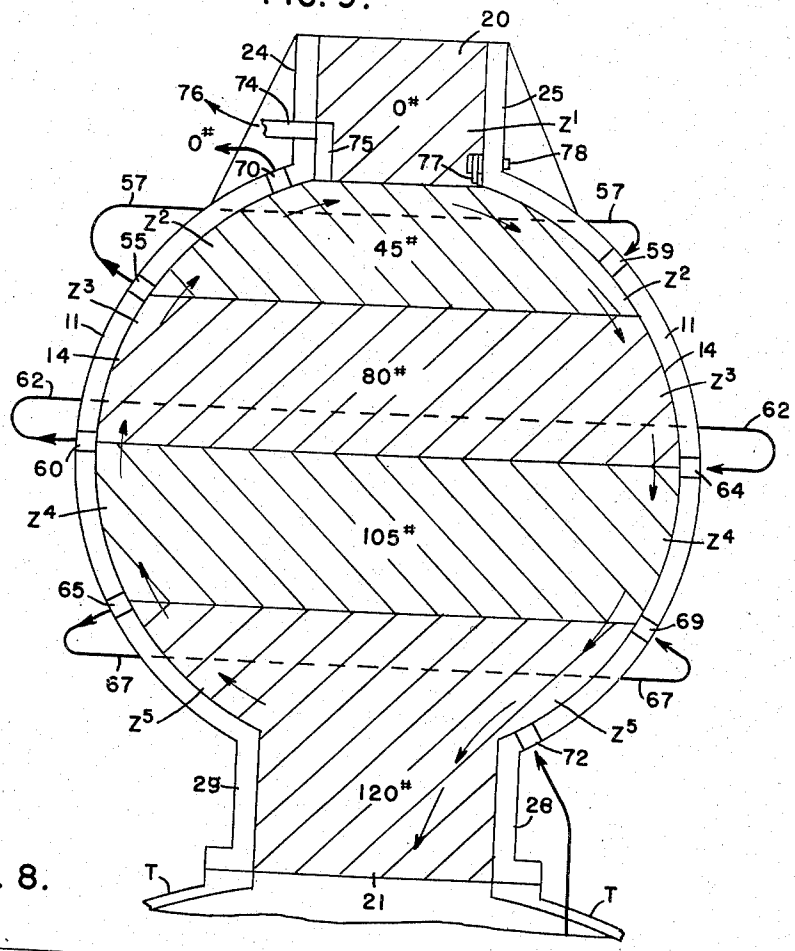


FIG. 8.

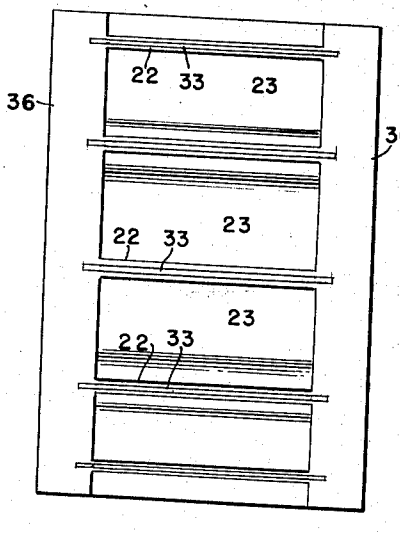
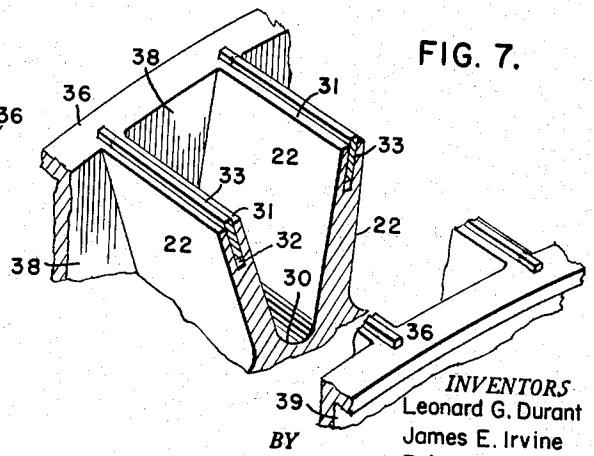


FIG. 7.



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2,858,212

WOOD CHIP FEEDERS

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Application February 13, 1956, Serial No. 565,113

10 Claims. (Cl. 92—7)

This invention relates to the paper making industry and more particularly to that station in a paper mill wherein ligno-cellulosic materials such as wood chips are digested. In the digestion or cooking of wood chips, they are subjected to steam-induced super heat and super pressure conditions within an enclosed chamber to which chamber they are continually fed at the top and continually discharged from the bottom. Various means have been devised and used for the continuous introduction of such chips from a bin or hopper holding a supply thereof while minimizing the escape from the chamber of steam and pressure. Such means have included rotary valves of various kinds, but invariably they have been unsatisfactory. Included among the reasons for this are: that the chips carry a lot of abrasive substances like sand that effect excessive wear on the moving parts so too much steam is lost; there is arching of the chips so that the feed through the valve is not uniform; and the differences between the maximum pressure on some parts compared with the minimum pressure on others, is so great as to interfere with good operation. So it is an object of this invention to devise a rotary feeder that will overcome these difficulties. Some inventors have gone so far as to get away from rotary valve feeders, by devising reciprocating plungers for forcing the chips under great compaction into the chamber. But it has been found that such compaction is degrading to the fibers ultimately recovered from the chips, so it is an object of this invention to arrange the rotary feeder thereof to operate in a manner that will avoid all such degrading compaction. It is another object to devise ways and means for exposing the chips on their way into the steam pressurized chamber from atmospheric pressure to pressure that is increased incrementally so that by the time they enter the chamber, they have been brought up to that pressure, step by step. Another object of this invention is to return to atmospheric pressure the empty chip-carrying devices or compartments under conditions of incremental decrease in pressure that are just the reverse of conditions encountered in their chip-carrying forward motion.

These objects, and possibly others that appear hereinafter, can be realized by an enclosed chamber adapted to subject such chips therein to steam-induced temperature and pressure while having means for evacuating treated chips therefrom and a bin for receiving and holding a supply of chips to be treated while discharging such chips at a uniform rate, characterized by means for receiving such discharging chips and moving them to enter the chamber that comprises a casing having a bore with a top chip-receiving inlet and a bottom chip evacuating outlet, a motivated rotor having an axle in the casing and a hub with a plurality of vanes or blades extending from the hub to the periphery of the bore of the casing with a chip-carrying compartment or pocket formed between pairs of adjacent vanes which during rotation of the rotor receives chips from the top inlet when the register therewith and delivers chips through the outlet from the casing when in register therewith, and means for incrementally

increasing steam pressure in sequential zones in the bore of the casing through which the pockets pass on their path toward the chamber from a pressure at the inlet equal to atmospheric to a pressure at the outlet equal to that in the chamber and on their return path toward the inlet whereby corresponding pairs of pockets on each vertical side of the axle are under the same pressure. Other features of importance reside in the construction; shape; location; and relationship between the vanes, the inlet and outlet; and the details of how the equalization of the pressure in the respective pockets is effected; as well as other details described and claimed hereinafter.

The invention is illustrated in the accompanying drawings in which Figure 1 is a diagrammatic showing of the environment of the invention. Figure 2 is a vertical sectional view (from left to right in Figure 1) of the feeder mechanism of this invention. Figure 3 shows a side elevational view of the feeder of Figure 2. Figure 4 shows a top plan view of the feeder. Figure 5 is a partial side elevational view looking toward the left in Figure 3. Figure 6 is a partial vertical sectional view (with all pipes omitted) along a line drawn vertically through Figure 4 along the line 6—6. Figure 7 is a partial isometric view with parts broken away, showing parts of the rotor 15 with its arrangement of vanes, seals, flanges, etc. Figure 8 shows a top plan view of the rotor. Figure 9 shows a somewhat diagrammatic view of the superposed zones of different steam pressure in the casing of the feeder.

Since this invention is devised to perform a certain function in a certain manner in a particular environment, it is believed that that environment should be understood first, so it has been illustrated in Figure 1, wherein ligno-cellulosic material such as wood chips are to be treated in the course of their cooking or digestion, in an enclosed steam heated and pressured chamber or tank T into which the chips are continually fed at the top by a feeder mechanism F and discharged from the bottom by an evacuator mechanism E, under conditions that there are always in the tank T a column of chips C, whose height is controlled to be substantially constant while made up of ever-changing individual chips which during their treatment in the tank continually move downwardly therein at a controlled rate. The feeder mechanism F for the chips is usually operated at a constant rate but chips are supplied thereto from a storage bin B for chips to be treated that is provided with an arch breaker A and a star wheel chip discharger S operated by a variable speed motor M, whose speed is controlled and regulated by a regulation circuit R on the tank. The regulator operates so that as the top of the column of chips C drops below a predetermined elevation, the variable speed motor M on the star wheel discharger S speeds up to deliver more chips to the tank, or slows down to deliver fewer chips to the tank when the chips rise above a predetermined elevation.

The enclosed tank T contains steam-induced temperature and pressure, with the pressure being the order of 120 pounds per square inch gauge pressure, so the chips, which incidentally are of a size and roughly of a shape ranging from that of a silver dollar downwardly, have to be fed into the tank T starting from atmospheric pressure to 120 p. s. i. g. in the tank. At the same time, the feeding must be such as to minimize escape of steam and pressure from the tank, and that is to be accomplished by the feeder mechanism F.

This feeder mechanism station F comprises a casing 11 that is generally cylindrical but having open ends 12 and 13. It has an internal bore 14 in which rotates a rotor having a hub 15 secured to a shaft or axle 16 journalled in suitable bearings 17 and 18. The casing has a top chip inlet 20 leading from the star wheel chip discharger S through the pipe 19 and communicating with the bore 14. It also has a bottom chip outlet 21 likewise com-

municating with the bore and leading into the tank T, but with the outlet being larger than the inlet. The hub 15 of the rotor is equipped with a plurality of blades or vanes 22, while formed between pairs of adjacent vanes are chip-carrying closed ended pockets 23. The inlet 20 has a side wall 24 that is first encountered or passed under by the moving vanes, and a side wall 25 that is last passed under by the moving vanes as they move clockwise, as shown in Figure 2. Its two other side walls are shown at 26 and 27. The outlet 21 also has a side wall 28 that is first encountered or passed by the moving vanes, and a side wall 29 that is last passed by them.

The vanes extend from the rotor at a particular angle, namely substantially at a tangent to the hub and axle, or perhaps another criterion is that each vane when moving under the first encountered side wall 24 of the inlet 20, should be substantially parallel to that side wall, for a reason given hereinafter. So each pocket 23 is shaped by the intersecting angularity of pairs of sequentially adjacent vanes, which vanes form the sides of the pocket, but the right hand vane (Figure 2) has much more inclination from the vertical than does the right hand vane when the pocket formed therebetween is under the inlet 20. The bottom 30 of each pocket is rounded as shown, with a radius such that no individual chip is likely to become wedged therein but can always fall freely therefrom when the pocket is up-ended. The inlet 20 into the casing, and the outlet 21 therefrom are of a size larger than the mouth of one pocket so that they always have opening thereinto at least a portion of two pockets. In the case of the inlet this allows for the easy incremental loading of an aligning pocket with chips since the chips slide down the inclined leading vane to fill the bottom of the pocket first and as the vane continues under the pocket, chips then fill the pocket whereupon they are levelled off by the wiper 77. Similarly, but in reverse, the outlet permits unloading of chips from the pockets for enough time interval takes place to complete the unloading from at least two pockets.

The vanes 22 have a sloping free end edge 31, provided with a groove 32 in which is fitted a seal 33 against loss of steam and pressure. They are made of hard, strong, long-wearing, non-swelling, bearing type material, such as carbon with a low coefficient of friction. The end of the seal and the free end of the vanes are slopingly curved to be complementary to the inner periphery of the bore 14. The seals are spring biased by stainless steel springs such as shown at 34 for pressing the seals against that periphery. In Fig. 2, it can also be seen that the end edges 31 of the vanes are flared outwardly to enclose the ends of the seals, and that the sides 38 and 39 of the rotor provide end walls for the pockets 23, which sides 38 and 39 terminate in a laterally extending peripheral flange 36 on each side of the rotor 15 (see Figures 6 and 7). Indeed the rotor (Figure 8) is an integral unit including the vanes 22, pockets 23, side walls 38 and 39, seals 33, and lateral peripheral flanges 36. The flanges 36 are made steam-tight by packing 40 held in place by flanges 41 on rings 42 held tightly in place by a series of bolts 43. In the front wall 26 of the inlet 20 there is a recess 45 in which is seated a block 47 removably held by bolts 44, and in the other wall 27 of inlet 20 there is a similar recess 46 in which is seated a block 48 also removably held by bolts such as 44.

The rotor with its vanes and the pockets between pairs thereof rotate clockwise, as shown in Figure 2 so when a pocket comes to its zenith position and into register with the top chip inlet 20, the pocket becomes filled with chips and carries them along as the rotor rotates until a chip-bearing pocket comes to its nadir position and into register with the bottom chip outlet 21 whereupon the chips slide from the pocket downwardly through the outlet 21 to the treatment tank T therebelow. Continued rotation of the rotor carries the empty pocket back up to its zenith position. In passing from zenith position to nadir position while carrying chips, a pocket is referred to as an outgoing pocket or outbound, whereas in passing from nadir position to zenith position while not carrying chips, a pocket is referred to as an incoming or inbound pocket. In the preferred form there are 12 vanes and 12 pockets. A chip-carrying outward bound pocket in passing from its zenith position to its nadir position passes sequentially or consecutively through a plurality of zones of incrementally increasing steam pressure maintained in the bore 14 of the casing 11 as shown in Figure 9. The superposed zones are indicated by Z^1 as at the top with a pressure equal to that of the atmosphere; Z^2 next below with a steam pressure of substantially 45 p. s. i. g.; Z^3 a subjacent zone with a steam pressure of substantially 80 p. s. i. g.; Z^4 next below with a steam pressure of substantially 105 p. s. i. g.; and Z^5 a final zone with a steam pressure equal to the pressure then existing in the treatment tank T, say 120 p. s. i. g. In order to accomplish this pressure zoning or compartmenting of the pressured areas to be substantially horizontal and deep enough so that oppositely directed pockets—one inbound and one outbound—lie in the same zone of pressure, there is provided a series of radial pressure outlets 55 through casing 11 (at the left of Figures 2 and 9) and a corresponding or paired series of radial pressure inlets 59 at the right of 11, located about 180° from outlets 55, and these are connected together by means of manifolds 56 and 58 respectively and by a common pressure-equalizing pipe 57. This piping arrangement provides a pressure of say 45 p. s. i. g. in zone Z^2. Pressure of say 80 p. s. i. g. is provided in zone Z^3 by a similar arrangement comprising a series of radial pressure outlets 60 through casing 11 at the left and a corresponding or paired series of radial pressure inlets 64, located about 180° from outlets 60, through the casing 11 at the right thereof connected together by means of manifolds 61 and 63 respectively and by a common pressure-equalizing pipe 62. Similarly pressure in Z^4 is established and maintained by a series of radial pressure outlets 65 through casing 11 at the left and a corresponding or paired series of radial pressure inlets 69, located about 180° from outlets 65, through the casing 11 at the right connected together by means of manifolds 66 and 68 respectively and by a common pressure-equalizing pipe 67. Manifolds 56, 61 and 66 may be said to be pressure-receiving manifolds while manifolds 58, 63 and 68 may be said to be pressure-transmitting. There is also a series of radial pressure outlets 70 at the upper left of Figures 2 and 9 leading to a manifold 71 going to the atmosphere, and a series of diametrically opposite pressure inlets 72 leading from a manifold 73 connected to the interior of the tank T. Finally there is a steam exhaust duct 74 hooded as at 75 within the top chip inlet 20 and passing through its wall 24 to connect with the atmosphere by means of an exhaust fan 76.

In Figure 2 there is shown on the right hand wall 25 of the top chip inlet, a wiper blade 77 held in place by bolts 78 and plates or straps 79, for wipingly removing or rolling back chips, slivers and sawdust from the end edges of the moving vanes and their seals as they pass under the wall 25.

When it becomes necessary to remove and replace any one of the seals 33, this can be done by aligning the desired blade 22 with the inlet 20 (see Figures 2 and 6); unscrewing the bolts 44; lifting out the blocks 47 and 48; and then lifting out the seal 33 and replacing it with a new one.

In operation, the apparatus of Figure 1 is started up with chips being fed into the storage bin B where they are operated on by the arch breaker A and the star wheel chip discharger S operated by the variable speed motor M, whose speed is controlled and regulated by the regulation circuit R on the tank T. The regulator operates so that as the top of the column of chips C drops below a predetermined elevation, the variable speed motor M on the star wheel discharger S speeds up to deliver more chips to the feeder mechanism F or if the top of the column

of chips rises above the predetermined level, the variable speed motor M on the wheel discharger slows down to deliver fewer chips to that feeder mechanism F since that mechanism is rotated at a constant rate.

The chips are passed through that feeder mechanism whose details are shown in the other figures of the drawing, namely by dropping down the top chip inlet **20** of the casing **11** (Figure 2). Here, due to the tangential forwardly leaning inclination of the blades **22**, the chips complete filling the pocket **23** just passing away from under the inlet, and begins filling the pocket **23** coming into register with the inlet **20**. This feeding first to the leading edge of a pocket onto its leading inclined blade is important in accomplishing orderly filling of the pockets, and filling them completely. As the filled pocket moves forward, the chips in its top encounter the wiper blade which removes excess chips, slivers, and sawdust from the top of the seals **33**.

Continued rotation of the rotor **15** of the feeder brings the load of chips in each pocket successively into zones of increasing steam pressure Z^3, Z^4 and Z^5 (Figure 9) so that the chips are sequentially brought up to the digester pressure (120 p. s. i. g.) that is being maintained in the treatment tank T. When a pocket comes into register or alignment with the bottom chip outlet, they fall from the pocket into the tank T, and here again the tangential forward inclination of the blades helps also in the discharge of the chips as it did in their loading into the pocket. On the return path of the now-empty pocket, it passes upwardly sequentially through zones of diminishing steam pressure Z^5, Z^4, Z^3, Z^2 and finally to Z^1 whose pressure is atmospheric. However, as has been repeatedly proven in other designs of pocket feeders, there is a greater tendency for steam pressure to be trapped in the pocket rising in Z^1; because of inadequate means for removal of this steam, the pressure in Z^1 will act upwards to prevent chips from entering the pocket so it has been found helpful to provide, at this point, the final steam exhaust duct **75** and its hood **74**, connected to exhaust fan **76**, that is effective in forcibly reducing the steam pressure in Z^1 to atmospheric or less so that as it comes in register with the chip inlet **20** that is full of descending chips, it thereby insures the positive filling of Z^1 with chips. The residual steam in a pocket coming into register with the chips inlet is highly expanded, and it has been found that even a small amount of such expanded steam remaining in a pocket significantly retards its being loaded with a new supply of chips.

A rotary feeder of this type is subjected to difficult conditions of temperature change, abrasion, wear, steam loss, and so on, but they all seem to be compensated for in the design of this invention and where wear cannot be resisted, the wear-receiving seals have been made readily renewable.

As this invention may be embodied in several forms without departing from the spirit or essential characteristic thereof, the present embodiment is therefore illustrative and not restrictive, since the scope of the invention is defined in the appended claims and all changes that fall within the metes and bounds of the claims or that form their functional as well as conjointly cooperative equivalents, are therefore intended to be embraced by those claims.

We claim:

1. Continuously operable wood-chip digestion apparatus including an enclosed chamber adapted to subject such chips therein to steam-induced temperature and pressure; means for evacuating treated chips from the bottom of the chamber; a bin for receiving and holding a supply of chips to be so treated; means for discharging chips from the bin at a substantially uniform rate; and means for receiving such discharging chips and moving them to enter the chamber while minimizing escape therefrom of steam and pressure which comprises a casing with a bore having a top chip inlet connected with the chip-discharging means associated with the bin and a bottom chip outlet connected with the chamber, a motivated rotor having a horizontal axle in the casing and a hub with a plurality of vanes extending from the hub to the periphery of the bore of the casing with a chip-carrying pocket formed between pairs of sequentially adjacent vanes which during rotation of the rotor receives chips from the top inlet when in register therewith and delivers chips through the outlet from the casing when in register therewith, and means for incrementally increasing steam pressure in sequential superposed zones in the bore of the casing through which the pockets pass on their path toward the chamber from a pressure at the inlet equal to atmospheric to a pressure at the outlet equal to that in the chamber and the reverse on their return path toward the inlet whereby corresponding pairs of pockets on each vertical side of the axle are under the same pressure.

2. Apparatus according to claim 1, wherein of a pair of sequentially adjacent vanes forming a pocket therebetween, the trailing vane of the pair extends parallel to the first encountered wall of the chip inlet into the casing when a pocket is in register with that inlet.

3. Apparatus according to claim 1, wherein both the chip inlet into the casing and pocket the chip outlet from the casing is larger than the mouth of one pocket whereby they always have opening thereinto at least a portion of two pockets.

4. Apparatus according to claim 1, wherein that wall of the chip inlet to the casing first passed under by a moving pocket there is a steam escape conduit with which the moving pocket comes into register.

5. Apparatus according to claim 1, wherein the wall of the chip inlet to the casing second passed under by the moving pocket there are wiping means extending from the inlet for removing chips and slivers as well as sawdust from the vanes and their seals.

6. Apparatus according to claim 1, wherein at the free end edges of the vanes there is a replaceable seal outwardly pressed against the casing, and means are provided in the chip inlet to the casing for removing the replaceable seals therethrough and therefrom.

7. Apparatus according to claim 1, wherein in the top chip inlet there are means for conducting pressure from a pocket open to the inlet to the atmosphere.

8. Apparatus according to claim 1, wherein in the top chip inlet there are means for conducting pressure from a pocket open to the inlet to a fan which in turn transfers such pressure to the atmosphere.

9. Apparatus according to claim 1, wherein in the top chip inlet there are hooded conduit means for conducting pressure from a pocket open to the inlet to the atmosphere.

10. Continuously operable wood-chip digestion apparatus including an enclosed pressure-containing chamber adapted to subject such chips therein to steam-induced temperature and pressure, a bin for receiving and holding a supply of chips to be treated, and means for receiving chips therefrom and transporting them to and into the chamber without fiber-degrading mechanical compaction on the chips while minimizing escape from the chamber of steam and pressure; said latter means comprising an open-ended casing with a bore therein having a top chip inlet from the bin at atmospheric pressure and a bottom chip outlet to the chamber at the super pressure existing in the chamber, an axle in the bore, a rotor secured to rotate with the axle having a plurality of intersecting vanes extending from the rotor forming between each pair of adjacent vanes a chip-receiving and chip-carrying pocket, a first pressure-receiving manifold drawing off pressure from a passing pocket along a longitudinal line just in advance of the wall of the top chip-inlet first passed under by passing pockets, a first pressure-transmitting manifold delivering along a longitudinal line just in advance of the wall of the bottom

chip-outlet first passed under by passing pockets pressure received from a passing pocket to the pressure-receiving manifold for thus equalizing pressure within two diametrically positioned pockets, a second pressure-receiving manifold drawing off pressure from a passing pocket along a longitudinal line in a horizontal plane with the axle, and a second pressure-transmitting manifold delivering along a longitudinal line 180° removed from the second pressure-receiving manifold pressure received from the latter passing pocket for thus equalizing pressure within two additional diametrically positioned pockets.

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CERTIFICATE OF CORRECTION

Patent No. 2,858,212 October 28, 1958

Leonard G. Durant et al.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 6, line 24, after "and" strike out -- pocket --.

Signed and sealed this 16th day of February 1960.

(SEAL)
Attest:

KARL H. AXLINE
Attesting Officer

ROBERT C. WATSON
Commissioner of Patents