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[54] **PROCESS AND APPARATUS FOR TREATING SUCROSE BEARING MATERIALS**
16 Claims, 3 Drawing Figs.

[52] **U.S. Cl.** **100/37,** 100/75, 100/139, 127/43
[51] **Int. Cl.** **B30b 9/02,** B30b 15/30
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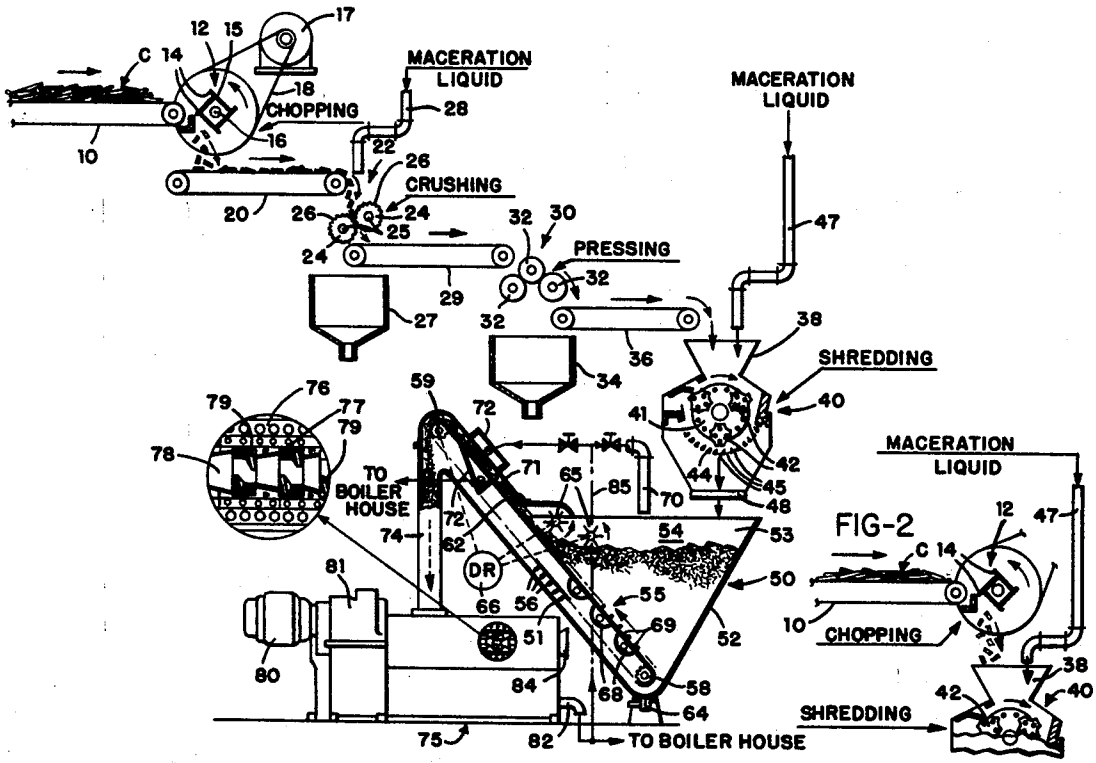
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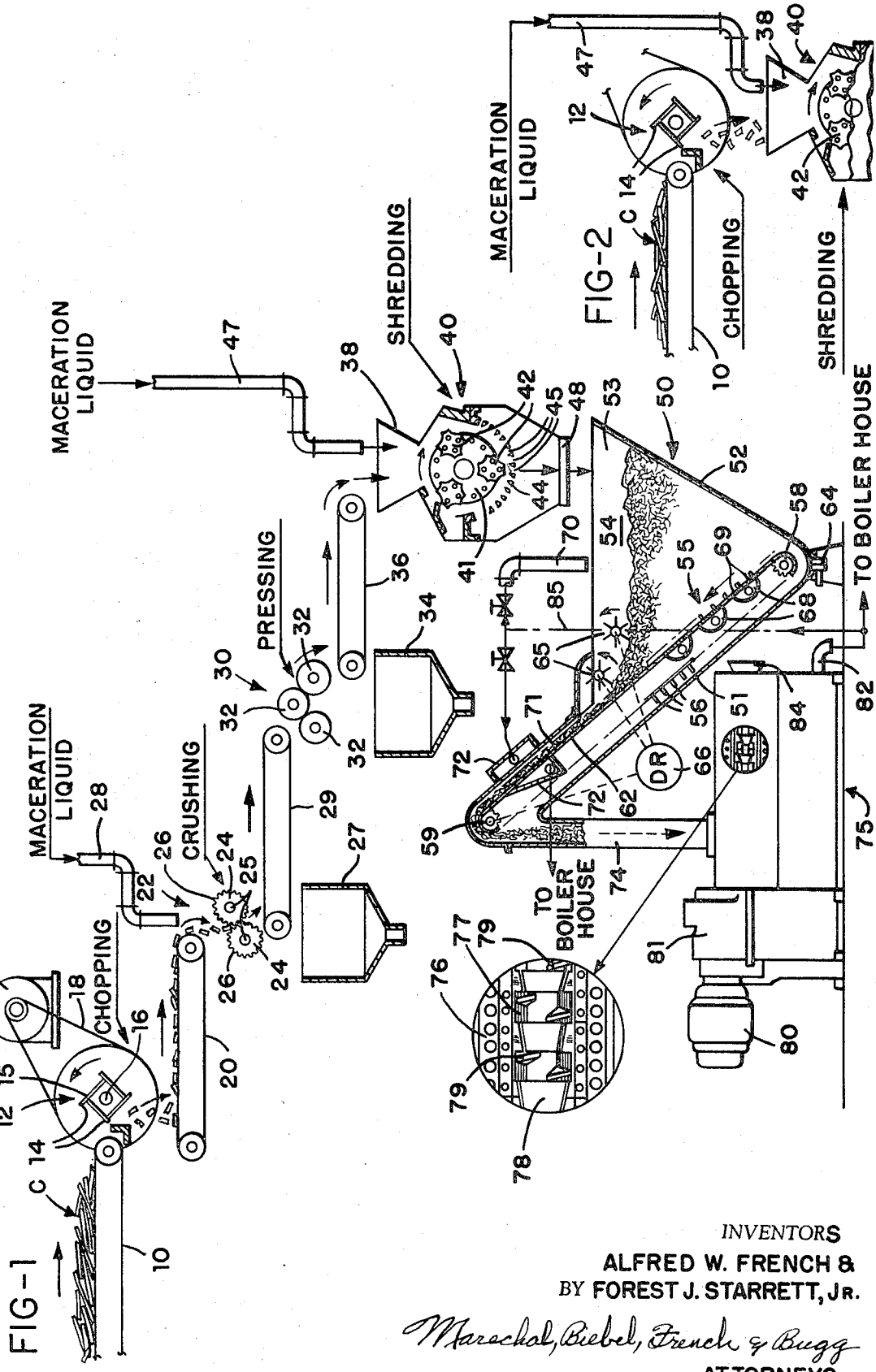
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ABSTRACT: Sugar cane or sugar cane bagasse is shredded to rupture a maximum of its cells, and is formed into a bed of generally uniform thickness on an endless conveyor. The bed is saturated with maceration liquid by directing a flow of liquid through the bed which is then fed into a mechanical press which carries away expressed liquid immediately as the material is pressed. Part or all of the expressed liquid is recirculated as maceration liquid. Some maceration liquid may be added during the shredding, and the shredded material may be detained before pressing to enhance maceration. The moving thick bed of the shredded material also acts as a filter to the liquid.





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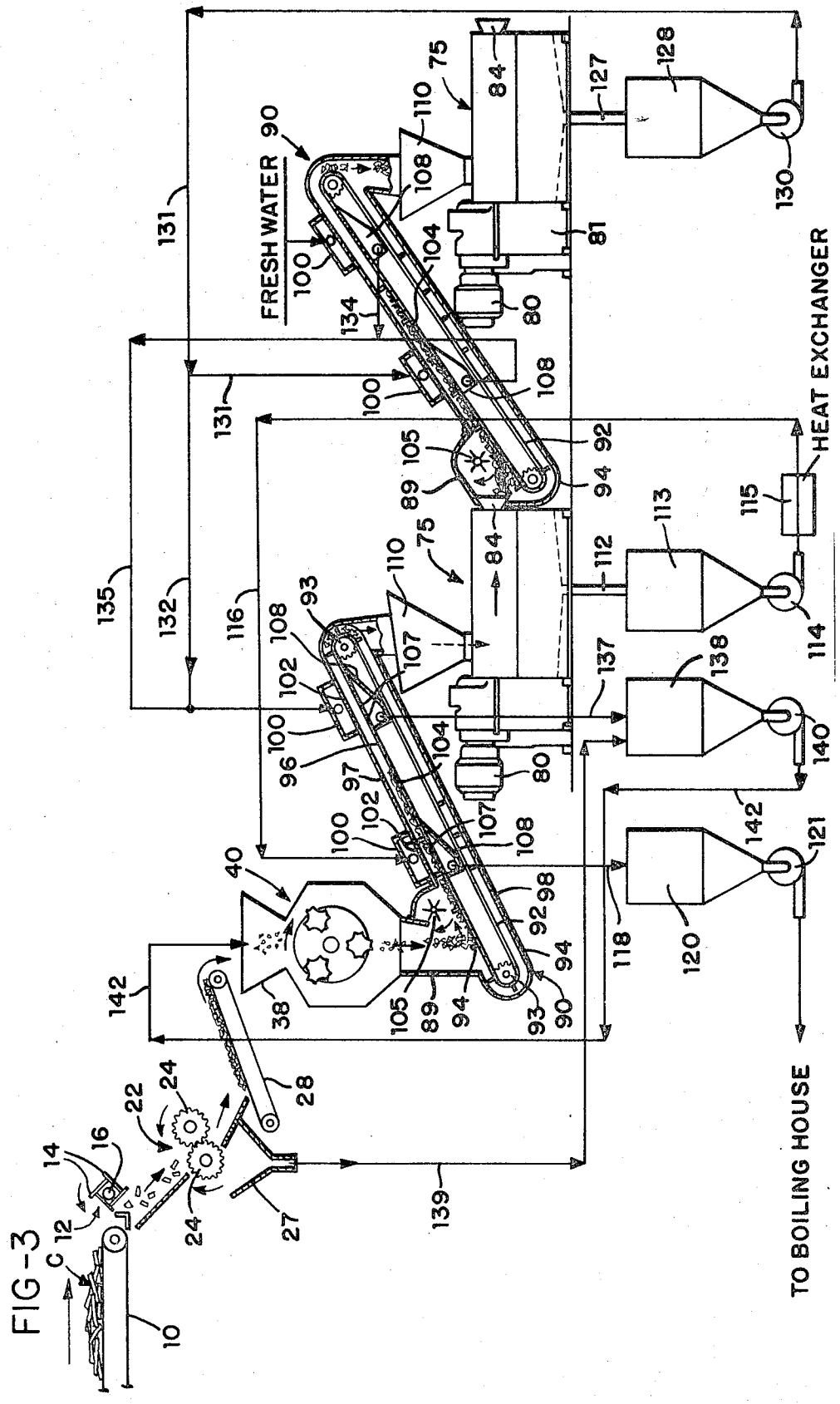


FIG-3

PROCESS AND APPARATUS FOR TREATING SUCROSE BEARING MATERIALS

BACKGROUND OF THE INVENTION

The invention has special relation to the process and apparatus disclosed in U.S. Pat. No. 3,195,466 and No. 3,086,452 respectively, which are assigned to the same assignee as the present invention. These patents relate to the use of a mechanical screw press for processing sugar cane or sugar cane bagasse, and particularly show the feeding of sugar cane directly into the press following a chopping, crushing or shredding operation, or feeding bagasse through one or more mechanical screw presses subsequent to the removal of a portion of the juice by one or more rolling mills. The patents also disclose adding maceration liquid between successive pressing stages performed either by rolling mills or screw presses.

It has been determined that a higher percentage of juice can be obtained from the sugar cane material by completely saturating the material with maceration liquid prior to feeding the material through a screw press. This requires soaking or otherwise subjecting the material to a high volume of maceration liquid and results in feeding into the press material containing a high percentage of maceration liquid. Such a high percentage of liquid is difficult to remove effectively by pressing the material within a roll mill, due to the fact that the nip formed by the rolls tends to force the maceration liquid back upstream within the material being fed into the nip. By feeding the saturated material into a press including a pressing surface having a substantial number of drainage openings, however, such as a mechanical screw press or cone-type disc press, the maceration liquid can be immediately removed through the drainage openings as the material is being pressed.

SUMMARY OF THE INVENTION

The present invention is directed to an improved process and apparatus for effectively saturating the material with maceration liquid and for effectively removing the liquid within one or more mechanical screw presses or disc presses, thereby obtaining a higher percentage of juice from the sucrose bearing material. The saturating is performed in such a manner that the liquid sent to the boiling house, contains high percentage of juice which provides for efficiently obtaining sucrose from the material.

Generally the process of the invention is performed by mechanically working the material, preferably within a shredder, to rupture the cells within the material. This material is substantially saturated with maceration liquid, such as water or recirculated juice or a combination of both to cause effective penetration of the ruptured cells. At least some of the maceration liquid can be added by flowing it through a thick moving bed of the material, which material will also act as a filter on the liquid. The saturated material is then pressed within a press having a pressing surface with substantial drainage openings so that juice along with the substantial volume of maceration liquid is released immediately as the material is compressed.

Accordingly, it is a primary object of the present invention to provide an improved process and apparatus for treating sucrose bearing fibrous material to obtain a high percentage of sucrose bearing juice from the material; to provide for mechanical working of the material to rupture the cells and then saturating the material with maceration liquid before the cells are pressed so that the liquid effectively penetrates the ruptured cells; to provide for pressing the saturated material within a press including a pressing surface having a substantial number of drainage openings to provide for immediate removal of the juice from the material; to provide for adding maceration liquid substantially simultaneously with rupturing the cells to produce rapid penetration of the liquid into cells; to provide for saturating or steeping of the material with maceration liquid comprising recirculated juice; and to provide for adding heat to the material during saturation to obtain more efficient operation of the press.

It is also the object of the invention to provide for shredding the material after an initial portion of the juice has been removed in a pressing operation for rupturing additional cells which will quickly receive maceration liquid; to provide for saturating the material by directing a substantial flow of recirculated juice through a material bed having a substantially uniform thickness; to provide for directing a second flow of maceration liquid through the saturated bed of material for displacing maceration liquid having a higher concentration of juice prior to pressing the material to obtain maximum juice removal with the presses; and to provide for pressing the material within a series of at least two mechanical presses each having a substantial number of drainage openings and with the material supplied to each press being saturated with recirculated juice to provide for sending liquid having the highest concentration of juice to the boiling house.

Other objects and advantages of the invention will be apparent from the following description, the accompanying drawings and the appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic illustration of apparatus for treating sucrose bearing material in accordance with the invention, showing an enlarged segment detail of the press;

FIG. 2 is a schematic illustration of a somewhat simplified form of the apparatus shown in FIG. 1; and

FIG. 3 is a schematic illustration of another form of apparatus connected and arranged for treating the material in accordance with the invention.

DESCRIPTION OF PREFERRED EMBODIMENTS

Referring to the drawing, the apparatus shown in FIG. 1 illustrates a method for treating raw sugar cane in accordance with the invention to obtain a high percentage of sucrose bearing juice from the cane. The raw cane material C is fed by a conveyor **10** into a chopper **12** including a plurality of cutting blades **14** extending from a hub **15** which is mounted on a shaft **16** driven by a motor **17** through a belt drive **18**.

The chopper **12** cuts or reduces the raw sugar cane material C into relatively short pieces which are discharged onto an endless belt conveyor **20**. A rotary crusher **22** receives the chopped cane material from the conveyor **20** and includes a set of crushing rolls **24** rotatably supported on parallel shafts **25**. The rolls **22** include circumferentially arranged teeth **26** which mechanically work the chopped cane and thereby rupture a substantial number of the cells of the material for releasing a portion of the juice. The juice released by the crusher is collected within a receptacle **27** and may be used as maceration liquid for subsequent saturation of the material. A conduit **28** is provided for introducing maceration liquid into the cane during crushing and to obtain some penetration of liquid into the cells as they are ruptured.

The crushed cane from the crusher **22** is delivered by a conveyor **29** to a conventional roller type mill **30** where the material is fed into the nips defined between a set of mill rolls **32** to squeeze out juice which drains into a receptacle **34**. A conveyor **36** delivers the bagasse from the roller mill **30** to the inlet hopper **38** of a shredder **40** (such as a hammermill) including a rotor **41** having a series of projecting knives **42** and a perforated screen member **44** defining discharge openings **45** of predetermined size. The shredder **40** further reduces the crushed cane and is effective to rupture most all of the cells which were not ruptured during crushing of the material.

In accordance with the invention, maceration liquid which may comprise only fresh water is introduced into the material through a line **47** while the material is being shredded so that the liquid can immediately penetrate the cells as they are ruptured. The shredded material and maceration liquid pass through the openings **45** and are discharged from an outlet **48** of the shredder into a soaking or steeping bin **50**.

The specific construction of the bin **50** is set forth in copending application Ser. No. 734,925, filed Jun. 6, 1968, now patented, which is assigned to the same assignee as the

present invention. The bin generally includes sloping bottom walls 51 and 52 connected by triangular shaped sidewalls 53 to define a chamber 54 having a V-shaped configuration. An inclined conveyor 55 is mounted within the chamber 54 and includes a series of laterally extending drag slats or members 56 mounted on a pair of endless chains 57 which are directed around a set of sprockets mounted on a shaft 58 located at the bottom of the hopper and another set of sprockets mounted on a shaft 59 supported by the extending portion 60 of the bin 50.

The upper reach of the conveyor 55 is supported by an intermediate wall member 62 extending parallel to the bottom wall 51 which supports the lower reach of the conveyor. A drain manifold 64 is mounted at the bottom of the bin 50 and is adapted to receive liquid from the chamber 54 to control the level of the liquid within the chamber. A set of rotary kicker members 65 are mounted within the upper portion of the bin in spaced relation from the wall member 62 and are driven by a variable speed drive 66 which is also connected to the sprocket shaft 59 for driving the conveyor 55. A series of conduit members 68 are mounted on the underneath surface of the wall member 62 and are connected to suitable lines for introducing either steam or hot water through small openings 69 formed within the wall member 62 to heat the material received within the chamber 54.

The shredded bagasse and maceration liquid discharged from the shredder 40 are received within the bin 50 so that the bagasse is soaked or steeped within the maceration liquid to assure that substantially all of the ruptured cells are penetrated by maceration liquid. A line 70 may also be used for adding additional maceration liquid.

After saturating the ruptured cells with maceration liquid, the material is fed upwardly from the chamber 54 by the conveyor 55 and the rotary kicker members 65 cooperate to roll or tumble the material above a predetermined distance from the wall member 62 back into the chamber 54 and thereby produce a material supply bed 71 which is substantially uniform in thickness. A manifold 72 is mounted on the top side of the projecting portion 60 of the bin 50 and is adapted to receive a flow of maceration liquid which is directed through perforations into the bed 71 of material to assure complete saturation of the material. Excess liquid which filters through the bed 71 is collected within a receptacle 73 and is directed to the boiling house for processing.

The heated material supply bed 71 is discharged downwardly through a chute 74 into the inlet of a mechanical screw press 75. As a result of the saturated condition of the material discharged through the chute 74, the material has a high percentage of maceration liquid contained therein. For example, the maceration liquid is substantially in excess of 30 percent by weight of the material and preferably in the order of between 60 percent to 120 percent by weight.

As also shown in the above-mentioned patents, the press 75 preferably includes a cage 76 lined with spaced screen bars 77 which form an inner pressing surface having a substantial number of drainage slots. An elongated screw 78 having interrupted flights 79, extends through the cage and is driven by a motor 80 through a gearbox 81. The juice or "press water" expressed through the drainage slots defined by the screen bars 77, is collected for discharge through a conduit 82 while the bagasse is discharged through the press outlet 84. As illustrated by the line 85, at least a portion of the juice or press water expressed from the material or bagasse by the press 75 is recirculated, either through the conduit 70 into the bin 50 and/or through the manifold 72, directly back into the material which is supplied to the press and serves as maceration liquid for saturating the material.

While a mechanical screw press 75 is shown in FIG. 1 for expressing the juice from the material in such a manner that the juice is released through the drainage slots or openings immediately as the material is compressed, it is also within the scope of the invention to employ a cone-type disc press wherein the opposing cones form pressing surfaces which include a substantial number of drainage openings. Thus when the saturated material is fed into the disc press, the combined juice and maceration liquid is expressed through the openings immediately as the material is compressed and thereby prevents maceration liquid from being forced back upstream within the material.

Referring to FIG. 2, it has been determined that the crushing and roll mill pressing operations may be omitted in some installations in which case the chopped cane C is fed directly from the chopper 12 into the inlet hopper 38 of the shredder 40. With this arrangement, more than one mechanical screw press 75 or disc press may be employed in a series with the bagasse discharged from the first press being fed into the inlet of the second press, and so on, with the addition of recirculated press water for saturating the material between successive pressing operations.

It is also within the scope of the invention that the material discharged from the first screw press 75 may be directed through another shredder 40 and then into another steeping bin 50 from where a uniform material supply bed of saturated material is supplied to the second screw press and so on in successive stages until substantially all of the sucrose bearing juice is removed from the bagasse.

It has also been found desirable to add lime to the shredded saturated material prior to feeding the material into a screw press. The lime increases the pH value of the material which substantially reduces the corrosive effects of the material and enables the screw press 75 and other following equipment to be constructed from less expensive materials which are not extremely highly resistant to corrosion. The lime also makes the material somewhat slippery which results in less power being required from the motor 80 to operate the screw press 75.

Referring to FIG. 3 which shows another form of apparatus constructed and arranged in accordance with the invention, the raw sugar cane material C is fed by the conveyor 10 into the chopper 12 and then through a crusher 22 where an initial portion of the juice is released from the cane material and is collected within the receptacle 27 in the same manner as described above the apparatus shown in FIG. 1. The crushed material is fed by the conveyor 28 directly into the inlet hopper 38 of the shredder 40. Thus in the embodiment of FIG. 3, the initial pressing operation performed by the roll mill 30 is eliminated.

The shredded material which is discharged from the shredder 40 is directed into a bin or hopper 89 formed at the lower end of an inclined drag conveyor 90. The conveyor is constructed somewhat similar to the conveyor 55 shown in FIG. 1 and includes a pair of endless chains 92 directed around sprockets 93 and carrying a series of laterally extending drag slats 94. The upper reach of the inclined conveyor 90 is supported by an intermediate wall 96 extending parallel to the upper wall 97 and lower wall 98 of the conveyor.

A pair of manifolds 100 are mounted on the upper wall 97 in vertically spaced relationship and each manifold is adapted to receive a flow of maceration liquid as will be described later. Openings 102 are formed within the upper wall 97 for directing the maceration liquid through a bed 104 of material produced by a rotary kicker 105 positioned in the hopper 89 in spaced relationship with the conveyor drag slats 94. A series of openings 107 are formed in the intermediate wall 96 generally opposite each group of openings 102 and open into corresponding collecting pans 108 mounted on the underneath surface of the intermediate wall 96 for collecting excess maceration liquid which filters through the bed 104.

The continuous supply bed 104 of material, which is generally uniform in thickness, is discharged from the conveyor 90 into a hopper 110 which directs the material into the inlet of a mechanical screw press 75. The juice or "press water" which is expressed from the material by the screw press 75 is directed by a conduit 112 into a collecting tank 113 from where the juice is recirculated by pump 114 through a heat exchanger 115 and conduit 116 back to the manifold 100 located adjacent the lower end portion of the conveyor 90.

The recirculated juice or press water which is heated by the heat exchanger **115**, filters through the bed **104** of material and is of sufficient volume to saturate substantially all of the ruptured cells of the shredded material. The excess press water or maceration liquid which filters through the bed **104** of material, is directed by a line **118** to a tank **120** from where the press water is directed by a pump **121** to the boiling house for processing.

The bagasse or pressed material discharged from the outlet **84** of the first screw press **75** is directed into the hopper **89** of a second conveyor **90** which feeds the material to the inlet hopper **110** of a second screw press **75**. In the same manner as described above for the first conveyor **90**, the bed **104** of material fed to the second press **75** is saturated by recirculated juice or "press water" which is removed by the second screw press **75**. That is, the press water from the second press is directed by a conduit **127** into a tank **128** and is directed by a pump **130** through a line **131** to the manifold **100** adjacent the lower portion of the second conveyor **90** to assure saturation of the bed **104** of material fed up the inclined second conveyor. A line **132** carries any excess press water to the manifold **100** on the upper portion of the first conveyor.

Fresh maceration water is supplied to the upper manifold **100** on the second conveyor **90** and serves to displace the more concentration recirculated press water which is collected within the upper pan **108** and is directed by a line **134** to a line **135** which directs the excess maceration liquid filtering through the material discharged from the first press **75**, to the manifold **100** adjacent the upper portion of the first conveyor **90**. Thus the material which is received by the second press **75** is saturated by substantially fresh water which results in obtaining a substantially high percentage of juice from the material.

Since the diluted juice or press water removed by the second screw press **75** has a lower percentage or concentration of juice than does the press water expressed from the material by the first screw press **75**, the filtered maceration liquid from the second press, which is directed by the line **135** into the upper manifold **100**, displaces more concentrated maceration liquid which is forced into the upper pan **108** and is directed by a line **137** into a tank **138**. The tank **138** also receives through a line **139** the juice collected within the receptacle **27**.

A pump **140** recirculates the liquid from the tank **138** through a line **142** to the inlet hopper **38** of the shredder **40** for macerating the cells of the material immediately as the cells are ruptured by the shredder. The relatively concentrated liquid is then displaced to some extent by recirculated press water directed into the lower manifold **100** and is collected within the tank **120** as mentioned above. Preferably, lime is added to the fresh water directed into the upper manifold **100** of the second conveyor **90** and/or to the press water directed into one of the other manifolds **100** to increase the pH value of the material entering the presses and decrease its corrosive effects. It has also been found that the addition of lime to the bed of material supplied to each press provides the material with a slippery effect and thereby significantly decreases the power required to operate the presses.

From the drawings and the above description, it can be seen that the process and apparatus of the invention provide several desirable features and advantages. For example, by introducing substantial maceration liquid into the material so that the liquid is present either while the cells are being ruptured and/or before the material is pressed, the maceration liquid effectively penetrates the ruptured cells to saturate the material which enables a higher percentage of juice to be removed from the material within a mechanical screw press or a disc press including a pressing surface having a substantial number of drainage openings.

The steeping bin **50** and conveyors **90** also provide important features of the invention. That is, the soaking or steeping of shredded material within the bin **50** in the presence of substantial maceration liquid or the flow of recirculated juice or press water through the bed of material within each of the conveyors **90**, assures complete saturation of the material. The conveyors **90** also provide for successive displacement of maceration liquid with maceration liquid having a lower juice concentration. Thus the maceration liquid supplied to the shredder **40** combines with the juice released from the cells by the shredder and is then displaced to some extent by less concentrated recirculated press water at the lower end of the first conveyor **90** so that the liquid having a high concentration of juice is sent to the boiling house.

The present invention also provides for shredding the material after some of the juice has been removed within a pressing operation. That is, by shredding the material after pressing, as illustrated in FIG. 1, and then adding maceration liquid, either during shredding or in a steeping bin or by directing a flow of liquid through a bed of the material, the liquid effectively penetrates the ruptured cells.

The use of recirculated press water or juice also forms an important feature of the invention. That is, by recirculating the juice expressed by each screw press **75** directly back into the material received by the press, effective saturation of the material is obtained with the use of a minimum volume of fresh water which is usually available in only limited supply. This direct recirculation also provides for sending to the boiling house the liquid having the highest concentration of juice and thus requires the minimum amount of energy for subsequent processing of the juice.

Furthermore, by heating the material within the steeping bin **50** with the addition of hot water or steam through the conduit member **68** (FIG. 1) or with the heat exchanger **115**, it has been found that a higher percentage of juice can be removed from the material with the screw presses **75** while requiring less power from the motor **80** for driving the press. The specific advantages obtained by heating the material before feeding it into a mechanical screwpress or disc press are set forth in copending application Ser. No. 490,329, filed Sep. 27, 1965, now U.S. Pat. No. 3,373,679, also assigned to the assignee of the present invention.

While the forms of process and apparatus herein described constitute preferred embodiments of the invention, it is to be understood that the invention is not limited to these precise forms of process and apparatus, and that changes may be made therein without departing from the scope of the invention which is defined in the appended claims.

We claim:

1. An improved process for treating sucrose bearing cellular fibrous material such as raw sugar cane or sugar cane bagasse to remove a high percentage of juice therefrom, comprising the steps of mechanically working the material to rupture the cells of the material, substantially saturating the material with maceration liquid to obtain effective penetration of the liquid into the ruptured cells, pressing the saturated material within a mechanical press including a pressing surface having a substantial number of drainage openings for releasing juice combined with maceration liquid immediately as the material is compressed, and recirculating at least a portion of the juice extracted by said press directly back into the material received by said press to provide at least a portion of said maceration liquid.

2. A process as defined in claim 1 wherein said step of pressing includes pressing the material with progressively increasing pressure within a mechanical screw press.

3. A process as defined in claim 1 wherein the step of mechanically working the material includes shredding the material within a hammermill-type shredder.

4. A process as defined in claim 3 including the step of pressing the material prior to said shredding for removing a portion of the juice from the material so that the maceration liquid effectively penetrates the ruptured cells.

5. A process as defined in claim 1 including the step of collecting the worked material within a bin having means for retaining said maceration liquid for steeping the material, and conveying a uniform bed of material from said bin to said press.

6. A process as defined in claim 5 including the step of introducing hot fluid into the material within said bin for heating the material, and directing at least a portion of the juice from said press into said bed of material fed into said press to assure saturation of the ruptured cells with maceration liquid.

7. An improved process for treating sucrose bearing cellular fibrous material such as raw sugar cane or sugar cane bagasse to remove a high percentage of juice therefrom, comprising the steps of mechanically working the material with a shredder to rupture cells in the material, pressing the material within a mechanical press including a pressing surface having a substantial number of drainage openings to provide for immediate release of the juice as the material is pressed, and introducing maceration liquid into the material causing the liquid to be present within said shredder immediately when the cells are ruptured to provide quick penetration of the maceration liquid into the cells.

8. The process as defined in claim 1 wherein the saturated material fed into said press includes maceration liquid substantially in excess of thirty percent of the fibrous material by weight.

9. An improved process for treating sucrose bearing cellular fibrous material such as raw sugar cane or sugar cane bagasse to remove a high percentage of juice therefrom, comprising the steps of mechanically working the material to rupture the cells of the material, feeding the worked material onto an endless conveyor before the material is pressed, forming the material on said conveyor into a bed of generally uniform thickness, conveying the bed of material to a mechanical press including a pressing surface having a substantial number of drainage openings, directing a flow of maceration liquid through the bed of material on said conveyor to effect penetration of the maceration liquid into the ruptured cells and substantial saturation of the material, pressing the saturated material within the press for releasing juice combined with maceration liquid immediately as the material is compressed, and recirculating at least a portion of the juice extracted by said press directly back and through the bed of material on said conveyor and received by said press.

10. A process as defined in claim 9 wherein the step of mechanically working the material comprises shredding the material, and including the step of introducing maceration liquid into the material causing the liquid to be present within said shredder when the cells are ruptured to effect quick penetration of the liquid into the cells.

11. A process as defined in claim 9 including the step of collecting the worked material within a bin before forming said bed of material, and steeping the material with heated maceration liquid within said bin.

12. A process as defined in claim 9 including the step of directing the bed of material upwardly with said conveyor as the material is being conveyed to said press, and directing a second flow of maceration liquid downwardly through the bed at an elevation above the first flow of maceration liquid.

13. A process as defined in claim 9 including the step of forming the material discharged from said press into a bed of substantially uniform thickness, conveying the bed of material to a second said press, and substantially saturating the bed of material being conveyed to the second said press by directing a flow of maceration liquid comprising recirculated juice from said second press through said bed of material.

14. A process as defined in claim 9 including the step of directing a second flow of maceration liquid through said bed after substantially saturating the material with the first said flow displacing maceration liquid having a higher concentration of juice prior to pressing the material.

15. A process as defined in claim 13 including the step of directing a second flow of maceration liquid comprising fresh water through said bed of material conveyed to said second press for displacing said recirculated juice prior to pressing the material within said second press.

16. A process as defined in claim 13 including the steps of collecting the excess maceration liquid which filters through said bed conveyed to said second press, directing said excess liquid through the bed conveyed to said first press after said bed is saturated, and collecting the excess maceration liquid which filters through said bed conveyed to said first press from the first said flow of maceration liquid to provide for removing sucrose from the liquid having the highest concentration of juice while also providing for substantially saturating the material conveyed to each said press.