April 23, 1963 A. W. FRENCH 3,086,452

APPARATUS FOR RECOVERY OF JUICE FROM SUCROSE BEARING MATERIALS

Filed July 9. 1957 4 Sheets-Sheet 1

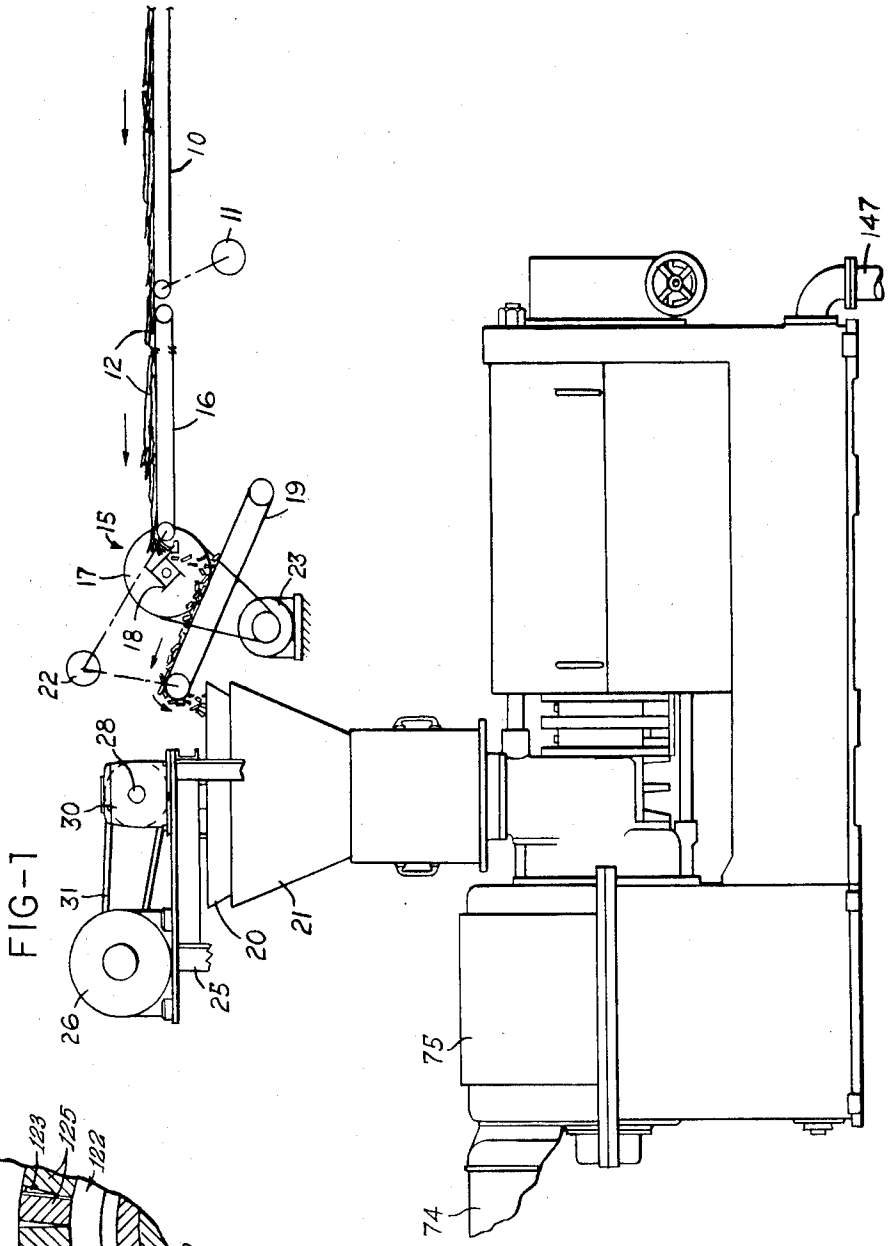


FIG-1

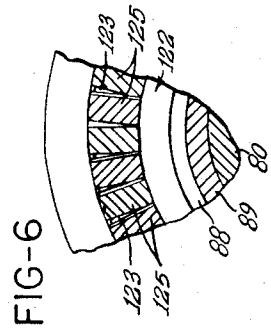


FIG-6

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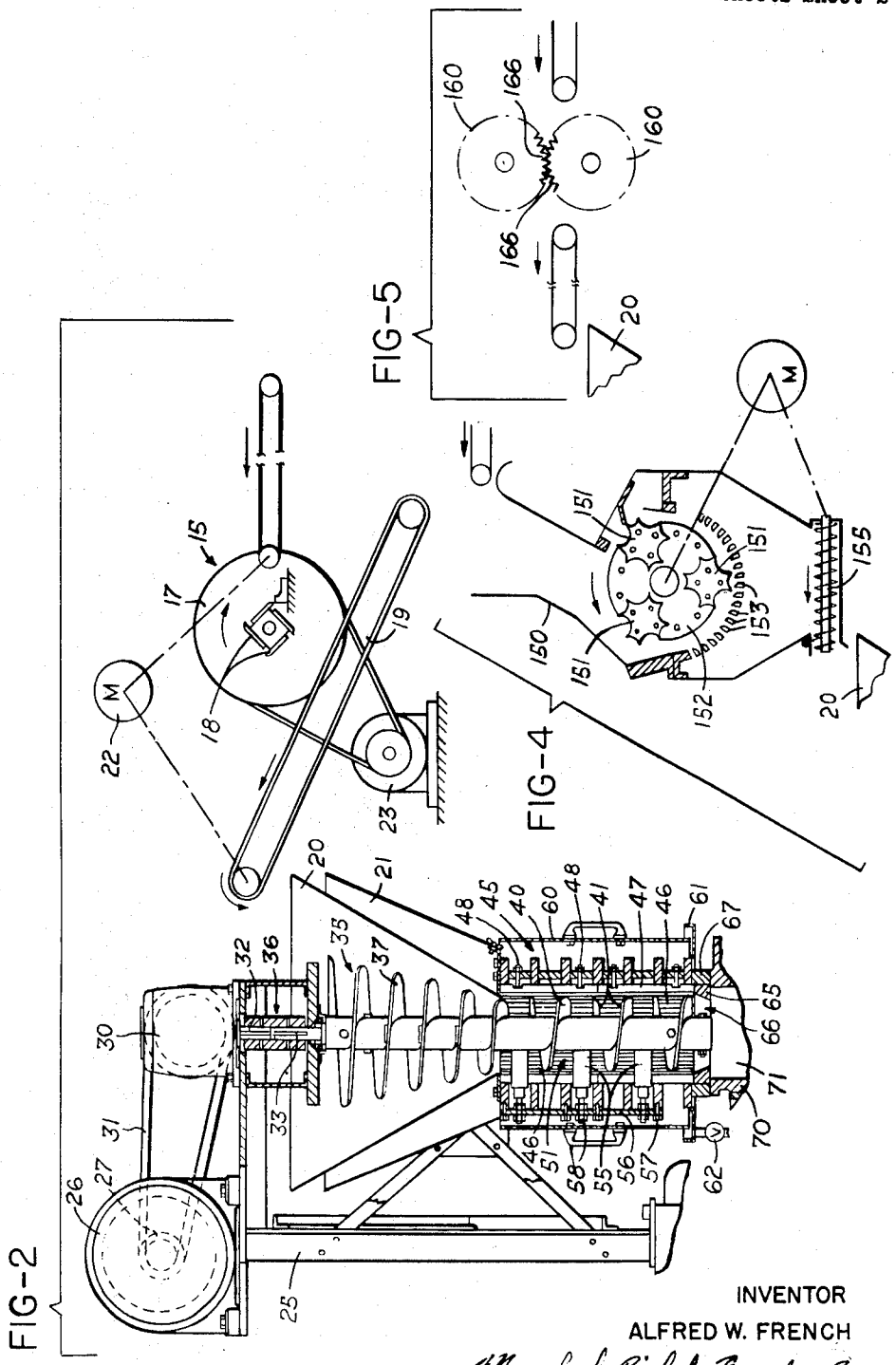
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APPARATUS FOR RECOVERY OF JUICE FROM SUCROSE BEARING MATERIALS

Filed July 9, 1957 4 Sheets-Sheet 2



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APPARATUS FOR RECOVERY OF JUICE FROM SUCROSE BEARING MATERIALS

Filed July 9. 1957 4 Sheets-Sheet 3

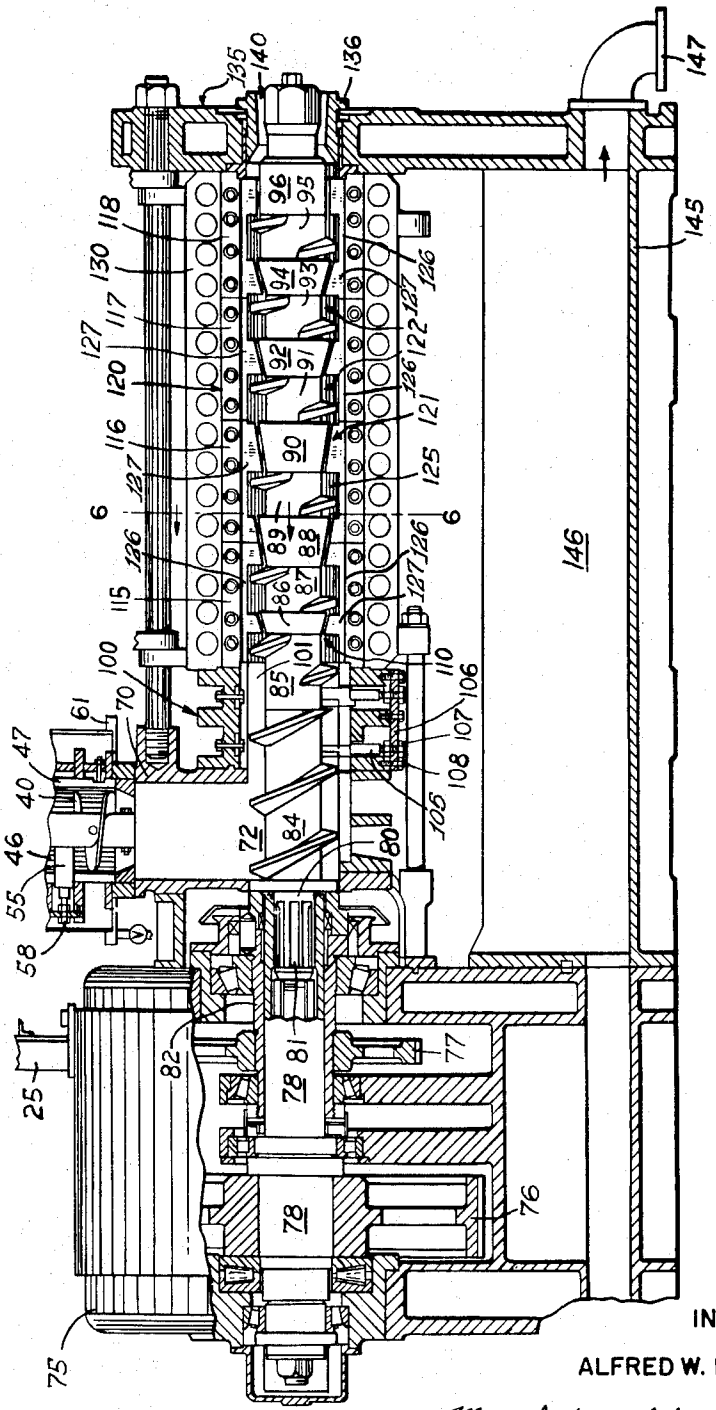


FIG-3

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April 23, 1963 A. W. FRENCH 3,086,452

APPARATUS FOR RECOVERY OF JUICE FROM SUCROSE BEARING MATERIALS

Filed July 9. 1957 4 Sheets-Sheet 4

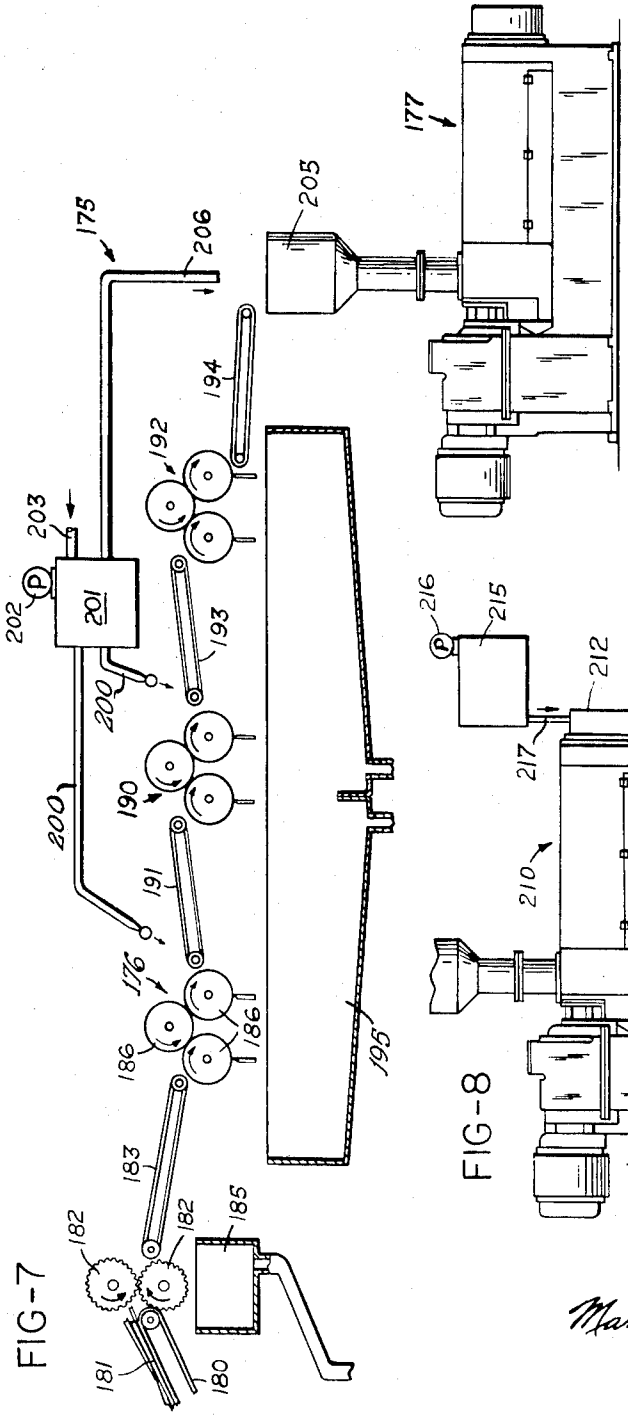


FIG-7

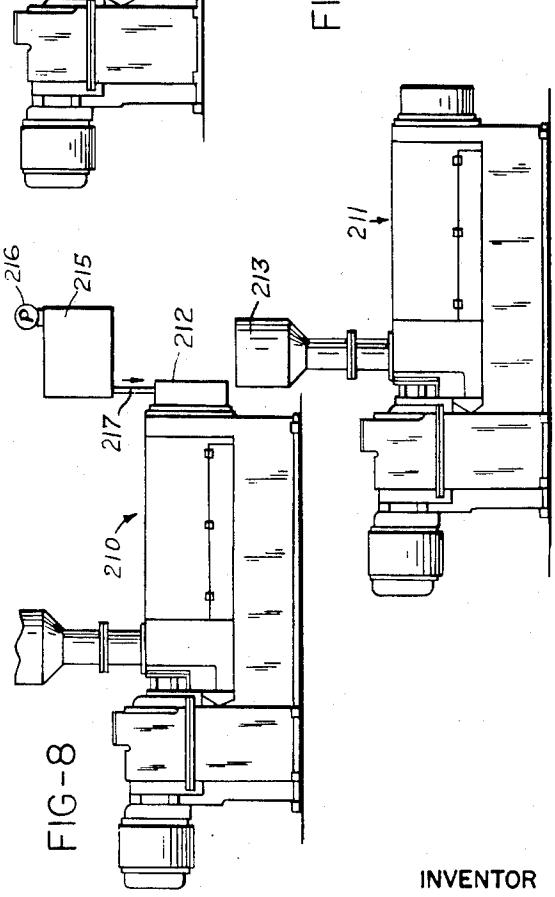


FIG-8

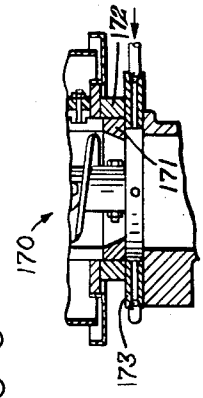


FIG-9

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United States Patent Office 3,086,452
Patented Apr. 23, 1963

3,086,452

APPARATUS FOR RECOVERY OF JUICE FROM SUCROSE BEARING MATERIALS

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Filed July 9, 1957, Ser. No. 670,743
2 Claims. (Cl. 100—75)

A primary object of this invention is the provision of an apparatus for expressing juice from sugar cane in which a high percentage of the cane juice is expressed from the cane through the substantially continuous application of high mechanical pressure, and in which the bagasse fiber is discharged with a low retained moisture content.

Another object of this invention is to provide an apparatus for expressing juice from sugar cane in which the cane is defibered and the fibers mixed under sustained pressure to contribute to further expression of juice.

Another object of this invention is the provision of an apparatus for expressing juice from sugar cane in which the cane is frictionally heated during its movement through the expressing apparatus while under a high mechanical pressure to promote further removal of the juice from the cells.

Another object of this invention is the provision of an apparatus for recovering high percentage of the sucrose content of sugar cane through the use of a maceration fluid intermediate expressing stages.

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

In the drawings:

FIG. 1 is a somewhat schematic side elevation of apparatus used to carry out the present process;

FIG. 2 is a sectional side elevation of that portion of the apparatus which is used to prepare the cane for its primary juice expressing operation;

FIG. 3 is an in part sectional and in part full side elevation of a press used in conjunction with the cane preparing means of FIG. 2 to express juice from sugar cane;

FIG. 4 is a sectional side elevational view showing shredding means for cutting raw cane to suitable lengths;

FIG. 5 shows schematically the application of crushing rolls to prepare raw cane for entry into the expressing apparatus;

FIG. 6 is a fragmentary sectional view taken substantially along the line 6—6 of FIG. 3 and showing the screen bar cage structure;

FIG. 7 is a schematic elevation of a roll type expressing mill with an interrupted flight screw press positioned at the discharge end to receive bagasse and express additional fluid therefrom;

FIG. 8 is a schematic side elevation of two interrupted flight screw type expressing presses arranged in series with maceration fluid added between two presses; and

FIG. 9 is a slightly enlarged fragmentary showing a modification of the restricting orifice of FIG. 3 with a manifold for adding maceration fluid to the fibrous material as it passes through the orifice.

Successful commercial recovery of the sucrose found in sugar cane juice depends upon expression of the cane juice from the cane within the reasonably limited period of time when the percentage of sucrose present is at a maximum. Sugar cane, in some cases, decreases in sucrose content if permitted to stand in the field and overripen. On the other hand, if the cane is cut and not processed within a short time the sucrose content will further decrease due to partial inversion thereof. Thus, due to the critical nature of the time period within which

the cane must be worked to obtain the maximum sucrose recovery, cane mills are normally constructed to handle relatively large quantities of raw cane within a short period of time. Naturally any time the mill is forced to shut down to make repairs because of mechanical failures, valuable sucrose may be lost and the recovery operation become less efficient.

Present sugar cane processing factories, utilizing roller-type mills to effect crushing of the cane to express the juice therefrom, normally use sizeable quantities of maceration water intermediate successive crushing stages to achieve efficient recovery of the sucrose content.

The present invention, in many instances, makes possible the recovery of sucrose percentages approximately equivalent to those now obtained without the use of maceration or lixiviating liquids, as well as reducing the chances of sucrose loss occurring from interrupted mill operations in factories where one piece of machinery depends upon another. The present process and apparatus are also capable of utilizing maceration fluids in those instances where it is either desired or preferred. Since the present apparatus effects expression of the juice independently of any other apparatus, when a plurality of such devices are used they may be arranged to operate in parallel to handle the entire amount of cane being processed by the mill and the breakdown of one piece of apparatus will in no way affect the independent functioning of those remaining.

While the present invention will be hereinafter described with particular reference to the treatment of sugar cane, it also provides substantial advantages in handling other sucrose bearing fibrous material such as, for example, sugar beets and sorghum. Related apparatus and method for specific application in recovering increased quantities of sucrose from sugar cane, and more particularly from the trash or cush-cush fibers formed during the pressing operation, and otherwise improving the efficiency of existing extraction processes are described and claimed in copending application Serial No. 670,742 (now Patent No. 3,037,445) filed of even date herewith and assigned to the same assignee as the present application.

Referring now to the drawings which illustrate preferred embodiments of apparatus for effectuating the present process, a generally horizontally disposed conveyor **10** (FIG. 1), driven by a motor **11**, is provided for transportation of raw cane **12** into a cane chopper **15** where a feeding conveyor belt **16** can advance it into a rotary cutting mechanism **17** having a plurality of cutting blades **18** arranged around the periphery thereof. An upwardly inclined conveyor **19** positioned below blades **18** receives the chopped cane and dumps it into a cone-shaped hopper **20** which is protected by a cone cover **21**. Conveyors **16** and **19** are driven by the motor **22** illustrated diagrammatically in FIG. 1, while cutting mechanism **17** is driven by motor **23**.

Frame work **25** provides support for hopper **20** and also for a driving motor **26** which has its pulley **27** (FIG. 2) connected to the input shaft **28** of a gear box **30** by means of a belt **31**. The output shaft **32** (FIG. 2) of the gear box is operatively joined to the shaft **33** of a screw conveyor **35** through the connecting spline **36**. The upper portion of shaft **33** carries a continuous feeding vane **37** to move cane from hopper **20**, while that portion of shaft **33** extending beyond the lower limit of hopper **20** carries a series of interrupted feeding vane flights **40** which have spaces **41** between the adjacent ends of successive flights.

A vertically disposed expression cage **45** surrounds the interrupted vane flights **40** of screw conveyor **35** and includes a plurality of vertically disposed, radially spaced

screen bars 46 (FIG. 2), which are held in place by wedge bars 47, the wedge bars being adjustably secured to cage 45 by threaded fasteners 48. Screen bars 46 are spaced slightly apart to define fluid drainage openings between adjacent bars so that expressed juice can flow outwardly away from an expression chamber 51 formed by the bars. Extending through the screen bars 46 into the chamber 51 are a number of breaker bars 55 which are adjustably secured to force feed cage 45, through holding strip 56, as by bolts 57. The adjustable fasteners 58 on the outer ends of the breaker bars provide means for adjusting them radially into or out of the chamber 51 within the vertical spaces 41 between interrupted vanes 40 to stop rotary movement of the cane in the chamber and cause it to move axially downwardly therethrough.

Expression cage 45 is enclosed within an imperforate wall 60 which receives the expressed juice and directs it downwardly into a collecting trough 61 adjacent the lower end of the cage structure where the juice can be withdrawn through outlet valve 62 to any suitable collection receptacle.

A ring-like split cone 65, positioned adjacent the lower end of expression cage 45, has a tapered inner surface defining a restricting orifice 66 of less diameter than the diameter of chamber 51. A clamping ring 67 of slightly greater height than split ring 65 surrounds the split ring to hold it together and in operating position. Beneath restricting orifice 66 a vertically extending wall 70 defines a further chamber 71, of greater diameter than the orifice, where the cane is permitted to expand as it drops into press inlet chamber 72 (FIG. 3). Such collar arrangement is described and claimed in more detail in copending application Serial No. 645,165, filed March 11, 1957, and assigned to the same assignee as the present application.

A suitable drive motor 74, part of which is shown in FIG. 1, is mounted on a gear housing 75. Housing 75, containing a pair of driven gears 76 and 77 (FIG. 3), is mounted adjacent the wall 70, with gear 76 operably connected through a driving sleeve 78 to a longitudinally extending shaft 80, as by spline connection 81, and gear 77 operably connected through a sleeve 82 and dog 83 to a feed screw 84 which surrounds a portion of shaft 80 and extends longitudinally through inlet chamber 72. Gears 76 and 77 are driven through a suitable connection with motor 74, with gear 77 preferably being operable at a higher speed than gear 76 so that feed screw 84 may be rotated faster than shaft 80. Following feed screw 84 a plurality of alternately arranged screw flights 85, 87, 89, 91, 93 and 95 and pressure collars 86, 88, 90, 92 and 94 and a final discharge collar 96 are all keyed or otherwise suitably attached to the shaft 80 for rotation therewith.

A preliminary expression cage 100 begins at vertically extending wall 70 and surrounds a portion of feed worm 84 and screw flight 85 to define a preliminary expression zone 101. Cage 100 includes push through-type breaker bars 105, the breaker bars being adjustably secured to a holding strip 106 through adjustable fasteners 107. Screws 108 are then used to mount the holding strip 106 to the cage proper.

At the termination of preliminary expression zone 101 there is an inlet opening to a main expression chamber 110. A plurality of screen bar sections 115, 116, 117 and 118 make up an expression cage 120, and the aforementioned alternately arranged screw flights and pressure collars are located inwardly thereof. The areas between the collars and the expression cage 120 define zones 121 where primarily compacting and expression occur while the areas between the worm flights and the cage 120 define zones 122 where primarily defibering occurs. Expression cage 120 includes screen bars 125 with drainage openings obtainable by means of spacers 123 between them and breaker bars 126, which have a plurality of longitudinally and radially extending lugs 127 terminating just short of the outer surface of pressure collars 86, 88, 90, 92 and 94 and discharge cone 96 to cause primary longitudinal movement of cane over these collars without the presence of excessive rotary motion. Reinforcing structure 130 is present to strengthen the screen bar sections since large radial forces are exerted against them when the press is operating.

Satisfactory results have been obtained, reducing the moisture content of sugar cane to as low as 30%, with a press having a cage inner diameter of 8½ inches and having case hardened steel pressure collars and screw flights of the following dimensions. Screw flights and pressure collars 92–95 inclusive have been omitted in this example.

Table 1

Screw Flights and Pressure Collars	85	86	87	88	89	90	91	96
Diameters in inches	5 7/16	5 7/16–6½	6¼	6¼–6½	6¼	6¼–7¼	6¼	6¼–7¾
Length in inches	4⅛	4⅝	4⅛	4⅝	4⅛	3¼	4⅛	10⅛

Higher pressures can be obtained by either using longer collars or collars and worms of larger diameters should such higher pressure be needed or preferred.

The metals from which the press components are constructed are also significant when determining the dimensions of the components which can be used to obtain satisfactory results. For example, a Stellite coating will decrease the friction between these parts and the cane material and thereby make changes in press dimensions advisable, if the most efficient operating forces are to be obtained. Stellite is a series of alloys comprising cobalt-chromium-tungsten which are manufactured by Union Carbide & Carbon Company. A press using Stellite, omitting screw flight 85 and pressure collar 86, could have the remaining pressure collars and screw flights dimensioned as shown in Table 2.

Table 2

Screw Flights and Pressure Collars	87	88	89	90	91	92	93	94	95	96
Diameters in inches	5 7/16	5 7/16–6¼	5 7/16	5 7/16–6¼	6¼	6¼–7¼	6¼	6¼–7¼	6¾	6¾–7¼
Length in inches	4⅛	4⅝	4⅛	4⅝	4⅛	3¼	4⅛	3¼	4⅛	5⅛

The end structure 135 surrounding the remainder of shaft 80 beyond discharge cone 96 includes a cylinder 136 which controls the size of the outlet opening 140.

To collect juice as it is expressed from the cane in the preliminary and main expression zones 101 and 110, respectively, the press has a hollow supporting base 145 which defines a juice collecting chamber 146. As the juice is extracted through the expressing cage structure it drops to chamber 146 and flows through outlet opening 147 to a place of collection.

In certain instances it may be preferred that the raw

cane be reduced in size by other means than chopper **15**. One such means is the shredding apparatus **150** shown in FIG. 4, where raw cane is cut by shredding members **151** carried on a rotatable member **152**. As cane is fed into shredder **150** it is cut by members **151**, forced through the grid formed by bars **153** and reduced to a somewhat finer physical condition than is the case in the chopper-type cutter. After the cane passes bars **153** it falls into conveyor **155** which moves it into the hopper **20** for subsequent treatment.

A second cane cutting arrangement is provided by the crushing rolls **160** shown schematically in FIG. 5, which have a plurality of teeth **166** that crush or tear the cane into the desired sizes as it is passed between them toward hopper **20**.

FIG. 9 illustrates another manner in which sucrose bearing fibrous material can be subjected to serial compacting operations with the addition of maceration fluid between the expressing steps. Specifically, screw press arrangement **170**, which is analogous to the feeding arrangement utilizing cage **45** of FIG. 2, has a ring-like split cone **171** and clamping ring **172** which serve the same function as their counter parts of FIG. 2. In this case however a fluid injection manifold **173** is positioned beneath members **171** and **172** to supply fluid to the sucrose bearing material as it passes beyond the restricted opening defined by ring **171**. In this manner the cane is subjected to free moisture at a time when it is expanding, and free of any large restraining pressure so that it can readily absorb moisture.

Generally the present process for expressing juice from sugar cane comprises feeding raw cane **12** into cutting means **15** where it is reduced in size by chopping, shredding or crushing, depending upon the form of cutting apparatus used, and fed by conveyor **19** into the cane hopper **20**. A series of revolving cane knives, for example, mounted to cut or chop the cane as it moves on the conveying means is a good method for reducing the size of the raw cane. Once within hopper **20** the cane feeds downwardly through the action of feed worm **35** into the vertically arranged expression cage **45**. As the screw attempts to advance the cane through restricting orifice **66**, a back pressure is built up in the cane within the cage. The mechanical pressure thus exerted against the cane causes a rupturing of the juice containing cells contained in the sugar cane fibers with a consequent initial expression of juice through the spacings between cage bars **46**.

After passing through restricting orifice **66** the partially expressed cane material can either be treated with a maceration fluid from manifold **173** as it is expanding and extremely receptive to absorption of the fluid or, if the manifold is not used, can continue through further chamber **71** where the pressure is released and the material allowed to expand to substantially its original size without the addition of fluid. After chamber **71** the material enters press inlet chamber **72** where feed worm **84** moves it longitudinally toward the press inlet. Since feed worm **84** is driven by gear **76** at a higher rate of speed than the press screw flights are driven by gear **77** the cane is once again compacted, this time in the area defined by preliminary expression cage **100**. This second compacting achieves a secondary expression of juice from the cane, the juice flowing outwardly through the cage to chamber **146**.

The first screw flight **85** takes the compacted cane from cage **100** and moves it inwardly toward pressure collar **86** in a generally helical path which creates a defibering action under pressure with mixing of the fibers to achieve a reorientation of the cellular structure. Reorientation contributes to further expression of juice as the cane is forced over the collar **86**, where a crushing or expressing action occurs. Screw flight **87** operates in much the same manner as screw flight **85** in that it takes compacted material from an expressing zone, viz., that zone between collar **86** and screen bar section **115**, and defibers and mixes the fibers while moving them outward toward collar **88**. The worms and collars following worm **87** and collar **88** operate on the cane in the same manner except that the increased body diameters of worm **95** and discharge cone **96** cause a greater packing of the cane at the outlet end of the press.

Using a press of the dimensions set forth in Table 1, it has been found that sugar cane having an inherent moisture content of 85% yielded approximately 89.7% of its moisture content in the preliminary expression cage **100** of the main expression cage **120**. Thus, the bagasse had a final moisture content of about 32% with a sucrose content of 5.51%. In a second test using the same press, cane having the same inherent moisture content gave a recovery of 93.1% of the juice with a final sucrose content of 3.89% and a moisture content of 30.0%.

Thus, in passing through the press the cane material will be subjected to intermittently varying pressures by virtue of the fact that the maximum diameters of the compacting collars are greater than the maximum diameters of the screw flight bodies. This feature results in a partial relaxation of pressure while still maintaining continuous expressing pressure as the material clears the rearmost edge of each of said collars. While the precise conditions developed in the expression cage are not fully understood, largely because of the practical difficulties of accurately determining the pressure and other conditions at a series of points throughout the cage, it is believed that the action may be described generally along the following lines. As the pieces of cane are fed forwardly by the flights on the feed worm portion, they are packed into the first screw flight portion and because of the difference in the rate at which such flights are driven, a substantial pressure is developed on the cane in such first flight. This is accompanied by expression of juice through the screen bars and additional pressure is built up as the material passes over the first collar, and its rotation is interrupted by the breaker bars. This is accompanied also by a mechanical action which results in some defibering and reorientation, with the result that further juice is extracted and the fibers are advanced to the next flight which they encounter with a different distribution.

As the material continues its passage through the cage, it encounters successive interrupted flights alternating with the series of collars and breaker bars so that such crushing, defibering and reorienting occur successively. It will further be noted that the clearance on the last flight between the body of the flight and the inner periphery of the cage is less than that of the other flights, thus resulting in an increased pressure when the material reaches the discharge end. This not only contributes to a higher effective yield but also assures the more thorough working of the material to express the maximum amount of juice therefrom before it is finally discharged.

Since the mean pressure exerted on the cane material is between the pressure created by the screw flights and the pressure created by the pressure collars it is apparent that pressures below the mean pressure are used while the material is being mixed and defibered and pressures above the mean pressure are used when compacting the material to express the juice therefrom. Additionally, the mean pressure is ascendant because of the increased pressures created toward the outlet end of the press.

Although the forces against the material during its passage through the press are intermittently varying, it should be noted that the mean pressure is quite high, probably being in excess of 5,000 p.s.i., so that the pressure against the material is at all times on a high level. Maintenance of the pressure at a high level while it moves longitudinally through the press results in creation of frictional heat which materially raises the temperature of the cane and softens the walls of the parenchyma cells and fibrovascular bundles aiding the expression of juice from the cane. For example, the juice toward the discharge end of the press is at about a boiling temperature and the dis-

charged bagasse at about 180° F., the temperature of the bagasse probably being greater while in the press and cooling somewhat upon release due to expansion.

As the cane progresses through the press the juice is expressed in the compacting zones and falls into collecting chamber **146** from whence it is collected in a suitable storage receptacle. Expressed cane bagasse is discharged through outlet opening **140** into collection means separate from the juice collecting means so that no reabsorption of the juice can occur after the pressure is relaxed.

FIG. 7 of the drawings illustrates an apparatus **175**, comprising a roller type mill **176** and a screw type expressing press **177**, for removing the juice from sugar cane and related sucrose bearing fibrous material.

A conveyor **180** delivers raw cane **181** to opposed crushing rolls **182** which have serrated or otherwise suitably formed working surfaces to break the cane and deliver it onto a second conveyor **183** with 40% to 70% of the original juice content removed. The juice taken from the cane at this point can be collected in a receptacle **185** for subsequent handling or it can be combined with juice extracted in later operations. The second conveyor, **183**, is positioned to discharge the crushed cane into the nip of the mill rolls **186** of the mill **176**. From mill **176** the cane passes through the rolls of mills **190** and **192** by means of conveyors **191** and **193** and is finally delivered onto a discharge conveyor **194** as bagasse having from about 85 to 95% of its sucrose content removed. Fluid expressed from the cane during its passage through the mills is collected within a tank **195** and from there directed to a suitable point of collection. The recovery of such high percentages of sucrose is made possible by the addition of a suitable maceration liquid, such as water, to the cane through fluid conducting pipes **200** prior to its delivery to mills **190** and **192**. Fluid can be obtained from a tank **201** which is under pressure from pump **202**, the tank being supplied with fluid through an inlet pipe **203**.

The bagasse being discharged from mill **192** onto conveyor **194** is dumped into the feed hopper **205** of screw press **177** where it can be supplied with maceration fluid by means of a pipe **206** in those instances where preferred. Pipe **206** extends from the supply tank **201** to the hopper **205**. From hopper **205** the material moves downwardly into the interior of the press where it undergoes the same physical defibering and expressing treatment previously described in connection with the screw press shown in FIG. 3.

The screw flight and pressure collar dimensions used in the press when running bagasse may vary from the dimensions set forth in Tables 1 and 2, exemplary dimensions being set forth in the following Table 3.

Table 3

Screw Flights and Pressure Collars	85	86	87	88	89	90	91	92	93	94	95	96
Diameters in inches	5 7/16	5 7/16–6 1/4	5 7/16	5 7/16–6 1/2	5 7/16	5 7/16–6 1/2	5 7/16	5 7/16–6 1/2	5 7/16	5 7/16–6 1/2	6 1/4	6 1/4
Length in inches	6 3/8	2 1/2	4 1/8	4 5/8	4 1/8	4 5/8	4 1/8	3 1/4	4 1/8	3 1/4	4 1/8	5 1/8

In tests conducted at a feed rate of 2½ tons of cane per hour, without the addition of maceration water between the mill **176** and the press **177**, the mill discharged bagasse having a moisture content of 48.75% and a sucrose content of 2.78%. By then running this bagasse through hopper **205** and press **177**, the press being dimensioned according to Table 3, the bagasse moisture content was lowered to 33.0% while the sucrose content dropped to 1.93%, these figures representing considerable additional recovery of material from the mill bagasse. It is also important to note that the bagasse will have increased fuel value by virtue of the reduced moisture content, a significant feature due to the fact that many mills use the bagasse as fuel for operating the plants.

A second run which was conducted using bagasse with a moisture content of 48.75% and a sucrose content of 2.78% but adding 500 pounds per hour of maceration water to the material as it entered hopper **205** resulted in a bagasse discharge from screw press **177** having a moisture content of 37.0% and a sucrose content of 2.12%. The addition of this amount of water raised the moisture content of the bagasse to approximately 60% prior to the final expressing and defibering operation which occurs in the screw press.

A slightly modified form of apparatus for subjecting sucrose bearing materials to expressing operations with the addition of maceration fluid between the two operations is shown in FIG. 8. Here, two interrupted flight screw presses, **210** and **211**, are arranged in series so that the discharge opening **212** of press **210** will deliver bagasse into the hopper **213** of the second press. A fluid reservoir **215**, having a pump **216**, is provided with a pipe **217** for supplying maceration fluid to bagasse just as it is expanding upon leaving press **210**, thus insuring that the bagasse will quickly soak up a maximum amount of maceration fluid.

While the process and form of apparatus herein described constitutes a preferred embodiment of the invention, it is to be understood that this invention is not limited to this precise process and form of apparatus and that changes may be made therein without departing from the scope of the invention which is defined in the appended claims.

What is claimed is:

1. Apparatus for removing at least 80–85% of the juice from sucrose bearing cellular fibrous material such as sugar cane comprising the combination of means for reducing the cane to desired lengths, a first elongated expression cage having inlet and outlet openings and a through passage therebetween and drainage openings in the walls of said cage, said inlet opening being positioned to receive the raw cane from said reducing means, means providing a restricting orifice at said outlet opening, an interrupted-flight feed screw extending into said first cage and having means for rotation thereof to force the cane under mechanical pressure through said orifice to express an initial quantity of juice from the cane for discharge through said drainage openings in said first cage, a main expression cage having an inlet and an outlet and having drainage openings in the walls thereof, a closed expansion chamber connecting said main cage inlet to said outlet of said first cage for receiving the cane forced through said orifice, means connected to introduce maceration liquid into said chamber for absorption by the cane where the mechanical pressure thereon is relatively relaxed, a feed screw member extending adjacent said main cage inlet and having drive means for rotation thereof to take up cane from said chamber and feed it under relatively high mean mechanical pressure through said main cage, a main interrupted-flight screw member extending through said main cage and having means for rotation thereof at a slower speed than said feed screw member, and cooperating means on said main screw and the walls of said main cage adapted to defiber and to compact the cane alternately while the relatively high mechanical pressure is maintained thereon for expressing a major quantity of the juice therefrom.

2. Apparatus for removing approximately 80–85% of the juice from sucrose bearing cellular fibrous material such as sugar cane, comprising the combination of means for reducing the cane to desired lengths, a first elongated expression cage having inlet and outlet openings and a

through passage therebetween and having drainage openings in the walls of said cage intermediate said inlet outlet openings, said inlet opening being positioned to receive the raw cane from said reducing means, means adjacent said cage outlet opening providing a restriction to the flow of cane therethrough, a feed screw extending into said first cage and having means for rotation thereof to force the cane under mechanical pressure past said restricting means, said feed screw and said first cage including means for simultaneously mechanically working said cane during the feeding thereof to express an initial quantity of juice from the cane for discharge through said drainage openings in said first cage, a main expansion cage having an inlet and an outlet and having drainage openings in the walls thereof, means forming an expansion chamber connected to discharge into said main cage inlet and receiving the cane forced through said restricting means from said first cage, means connected to introduce masceration liquid into said chamber for absorption by the cane where the mechanical pressure thereon is relatively relaxed, a feed screw member extending adjacent said main cage inlet and having drive means for rotation thereof to take up cane from said chamber and feed it under relatively high mean mechanical pressure through said main cage, a main interrupted-flight screw member extending through said main cage and having means for rotation thereof to feed the cane through said main cage while retarding the flow thereof with respect to the flow from said feed screw member, and cooperating means on said main screw and the walls of said main cage adapted to defiber and to compact the cane while the relatively high mechanical pressure is maintained thereon for expressing a major quantity of the juice therefrom and for discharging from said main cage a defibered bagasse.

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