Apparatus for removing dirt and extracting juice from disintegrated sugar cane, having a tank in which the cane is washed in sugar juice, a conveyor for discharging washed cane from the tank and enabling diluent liquid sprayed on the discharging cane to rinse further dirt and displace rich juice therefrom, and a settling compartment connected to the bottom of the tank for receiving and separating dirt and rich juice.

23 Claims, 6 Drawing Figures
DISPLACEMENT RINSING APPARATUS

BACKGROUND OF THE INVENTION
Sugar cane received at a mill or other processing plant customarily is cleaned before being processed for juice and such cleaning is particularly essential, if, as in Hawaii, the cane is mechanically rather than manually harvested and consequently mixed with mud, sand, gravel and other dirt or debris. Formerly, the cane was wet cleaned by washing it with water to remove the dirt. However, experimental work recently conducted by the Hawaiian Sugar Planters Association, led to the discovery that a large amount of juice, containing about 15 percent pol in terms of the initial sucrose content, was lost with the wash water, and later to the development of a dry cleaner which reduced to about 8-9 percent the pol lost in juice mixed with the dirt, trash and short cane removed by the cleaning, with consequent potential gain of about 6 percent in the pol recovery. Although sound in theory, dry cleaning, at least in the present experimental stage, tends to leave in the cane enough dirt in the form of mud, sand and gravel to cause rapid wear of pumps and machines and otherwise impair the efficiency of the subsequent machinery or apparatus by which the cane is processed for juice, and the juice is then processed for sucrose. While not limited thereto, the present invention is particularly concerned with a solution of this problem.

SUMMARY OF THE INVENTION
The primary object of the present invention is to provide improved apparatus for removing dirt from disintegrated cane without loss of the juice contained therein.

Another object of the invention is to provide improved apparatus which not only removes dirt from disintegrated cane but in process extracts therefrom loosely held rich juice and separates the juice from the dirt.

An additional object of the invention is to provide improved apparatus for removing dirt from disintegrated sugar cane wherein the dirt is washed from the cane in a tank of rich juice and the washed cane is discharged from the tank by a conveyor so contained and upwardly sloping as to enable relatively dilute diluent liquid sprayed on the discharging cane toward the discharge end of the conveyor to establish with the rich juice in the tank a displacement interface for extracting rich juice by displacement from cane passing through.

A further object of the invention is to provide improved apparatus for treating disintegrated cane which by washing and rinsing not only removes dirt from the disintegrated cane and protects subsequent processing apparatus from the harmful effects thereof, but also enables rich juice to be extracted by displacement from the cane and rich juice and dirt to be separated and separately removed, the juice with fine screening for removing pith and like small particles otherwise detrimental to processing for sucrose and the dirt with water-washing to recover any juice mixed therewith.

Other objects and advantages of the invention will appear hereinafter in the detailed description, be particularly pointed out in the appended claims and be illustrated in the accompanying drawings, in which:

FIGURE DESCRIPTION
Fig. 1 is a somewhat schematic view of a partial juice processing line incorporating a preferred embodiment of the improved displacement rinser of the present invention;

Fig. 2 is a central longitudinal sectional view on an enlarged scale of the displacement rinser of Fig. 1;

Fig. 3 is a fragmentary end view of the discharge end of the displacement rinser, taken along lines 3-3 of Fig. 2;

Fig. 4 is a fragmentary sectional view taken along lines 4-4 of Fig. 2 but on a larger scale;

Fig. 5 is a fragmentary sectional view on the scale of Fig. 4, taken along lines 5-5 of Fig. 2, and

Fig. 6 is a fragmentary view on the section of Fig. 2 and a larger scale, showing in more detail the lower portion of the dirt discharge conveyor and associated structure.

DETAILED DESCRIPTION
Referring now in detail to the drawings in which like reference characters designate like parts, the improved displacement rinsing apparatus of the present invention is designed to remove dirt and extract free or loosely held rich juice from disintegrated cane before the cane is processed for juice by associated extraction apparatus. Although not supplanting wet or dry cleaning of cane as received from the field, the improved apparatus is capable of removing dirt, such as mud, sand and gravel, without appreciable loss of juice and therefore particularly useful in conjunction with dry cleaning for enabling the saving in juice of dry over wet cleaning to be retained for increasing the total juice recovery. These and other advantages hereafter to be pointed out, lend the improved apparatus to use with any form of extraction apparatus, such as a mill train, diffusion apparatus or the washing apparatus disclosed in my copending application Ser. No. 155,725, filed June 23, 1971. While in most installations the improved apparatus will be positioned in advance of the associated extraction apparatus, if, as in a mill train or combined mill train and washing apparatus, such as described in my copending application, the extraction is performed in steps or stages by a plurality of roll mills or other extraction units arranged in sequence, can be interposed between an adjoining pair of the units.

In the exemplary installation of Fig. 1, a preferred embodiment of the improved displacement rinser or rinsing apparatus, designated as 1, is part of a juice extraction line or plant, in which the associated extraction apparatus 2 is of the type disclosed in the above copending application. While, depending on its use, the extraction apparatus of that application may be of either single or plural container form, the single downwardly discharging container 3 and complementary or related devices or equipment, along with the other associated components of the partial line here illustrated, will suffice for an understanding of the invention.

As disclosed in detail in my copending application, disintegrated cane or bagasse in moving downwardly at a controlled rate of discharge through the container 3 is subjected to a plurality of washing effects with diluent liquid for extracting juice. Feeding is facilitated and extraction improved by mixing the bagasse with diluent liquid into a slurry or slurry mixture in a slurry tank 4 positioned in advance of the container 3 and pumping
the mixture to a screening device 5 atop the container for draining off the excess liquid and feeding the drained, solid state bagasse into the container's upper end. The excess liquid screened from the slurry mixture by the screening device 5 drains into a sump 6, carrying off with it any dirt in the form of mud, sand and gravel contained in the initial mixture. Gravity settlement in the sump separates the dirt and rich juice from the lighter, relative dilute slurry juice forming the bulk of the drained liquid. So separated, the dirt and rich juice are discharged from the bottom of the sump through a rich juice discharge pipe 7, while the slurry juice is discharged from a higher level through a slurry juice discharge pipe 8.

The dry state bagasse from the screening device 5, in moving downwardly as a column through the container 3, is subjected to a plurality of stages of washing with recirculated diluent liquid for extracting juice. Also, as the illustrated extraction apparatus 2 requires exposure of the juice in the bagasse to the washing liquid, the bagasse is heated, suitably by injecting steam directly into the container 3, to a temperature in the range of about 170°-190°F. so as to kill the walls of any previously unruptured cells and enable the contained juice and diluent liquid to pass or diffuse freely therethrough. Since continuously recirculated during operation of the apparatus, the diluent liquid will be correspondingly heated, as will the slurry mixture in the tank 4, the latter by directing thereto through a return pipe 9 to which the slurry juice pipe 8 leads, not only the slurry juice but part of the hot liquid drained from the first washing stage in the upper part of the container 3.

Other components of the illustrated partial juice processing line are a variable speed feed conveyor or elevator 10 receiving preferably dry cleaned cane from a dry cleaner (not shown) and feeding it to a cutter 11 for cutting the cane into short lengths. Following the cutter 11 is an intermediate conveyor 12, which, after carrying the cut cane past a magnet 13 for removing any tramp iron, discharges the cane into a disintegrator 14, suitably and preferably a shredder of the heavy duty Gruendler type, for disintegrating the cane into small pieces and in process rupturing most of the juice-containing cells.

Interposed or positioned in the illustrated installation between the shredder 14 and the extraction apparatus 2, the displacement rinser 1 of the present invention is comprised of a tank containing to a static level a large volume of rich juice for receiving and washing dirt in the form of mud, sand and gravel from disintegrated or shredded cane or bagasse discharged by the preferred shredder 14, a discharge conveyor 16 for removing washed cane or bagasse from the tank, and a settling or separating compartment 17 connected to the tank for receiving therefrom and separating dirt and rich juice. In the preferred embodiment, the tank 15, discharge conveyor 16 and settling compartment 17 conveniently are contained in and have a common, longitudinally elongated, suitably open-top or upwardly opening casing or housing 18, of which the tank and settling compartment form respectively intermediate and leading or front end portions and the trailing end portion is a discharge compartment or trough 19 housing the corresponding portion of the conveyor.

Within the casing 18, the tank 15 is open to the trough 19 but separated or divided from the settling compartment 17 by an intervening wall, partition or bulkhead 20 intermediate ends of and extending laterally across the casing. Designed not only to separate the tank 15 from the settling compartment 17 but to deflect or direct downwardly dirt washed in its vicinity from the shredded cane, the illustrated wall 20 is a zigzag wall formed of a plurality of successive, end-connected, angularly related panels 21, each sloping or inclined rearwardly and downwardly at an oblique angle sufficient to prevent retention of dirt thereon.

Bounded at the front by the dividing wall 20, the tank 15 has a foraminous or screened bottom or bottom portion 22 of screening sufficiently coarse to pass any dirt in the form of mud, sand and gravel contained in the shredded or disintegrated cane or bagasse discharged by the shredder 14. Sloping downwardly and forwardly toward the settling compartment 16, the tank's screened bottom 22 drains or discharges into an underlying, correspondingly sloping, sump or jacketed or bottom-enclosed drain passage 23 on the bottom of the common casing 18 and opening downwardly below the dividing wall onto the bottom portion of the settling compartment 17. Bounded at the front intermediate its vertical extremities by a preferably downwardly and rearwardly sloping front wall or wall portion 24 of the casing 18, which performs the same function relating to dirt as the dividing wall 20, the settling compartment 17 conveniently has as the lower part of its bottom portion a funnel or hopper 25 opening downwardly onto the lower or inlet portion of a dirt discharge tube or conduit 26. Obliquely disposed and extending from the inlet formed by the funnel 25 upwardly to and preferably above the top of the tank 15 and having an open upper or discharge end 27, the discharge tube 26 suitably is of rectangular cross-section and fitted for discharge with an endless bar or other suitable discharge conveyor or elevator 28 adapted by its lower or drive flight 29 to carry or transport any dirt received through its inlet up to its open upper end.

Since the tank 15, settling compartment 17 and dirt discharge tube 26 are interconnected or open to each other at the bottom and open at the top to atmosphere, liquid contained in any will be distributed among all and be at the same liquid level indicated at 30. In the intended operation of the apparatus, the liquid in the tank 15 is a liquid mixture of juice and shredded or disintegrated cane, while, with the interposed coarse screening 22 to strain out the fiber, that in the settling compartment 17 and discharge tube 26 is essentially juice. And, consistent with the rich juice loosened or released from the input cane by the shredder 14, the juice in the tank, settling compartment and discharge tube preferably is rich juice suitable for processing for sucrose as the product juice of the extraction line. Since heavier than the liquid, dirt washed out in the tank and discharged therefrom through the screened bottom 22, will slide or move downwardly along the drain sump 23 to the bottom portion of the settling compartment and drop through the funnel 25 into the discharge tube 26 through which it is carried or transported by the advance or drive flight 29 of the discharge conveyor 28 to and discharged from the tube's open end 27.

Since passing through juice until it reaches the liquid level 30 in the discharge tube 26, the dirt unavoidably will have some juice mixed with it on reaching that level. To recover that juice and prevent its loss from the extraction process, the conveyor and under part of the
discharge tube are extended substantially above the liquid level and the dirt in passing over the extension is washed with water sprayed thereon from an overlying, downwardly directed nozzle 31. At the same time, any substantial commingling of the wash water with the juice is prevented by containing or enclosing the advance flight 29 over most of its length by a container or baffle plate 32 in and extending across the discharge tube and longitudinally or axially thereof from a point above the liquid level 30 substantially to the inlet 25. So contained, any wash water that does pass down into the tube will be carried back by the conveyor and, along with the balance of the wash water, be discharged with the washed dirt.

While strained of cane particles too large to pass through the coarse bottom screen 22 of the tank 15, the juice in the upper part of the settling compartment 17 almost inevitably will contain particles of fiber and pith which would tend to clog the boiler house clarifiers (not shown) customarily used in processing product juice for sucrose. It therefore is desirable that such small particles of solid cane be strained out before the juice is discharged from the apparatus by a suitable fine screening device. One particularly suited for the purpose is the illustrated device 33 having as its fine screen 34 the perforated lower part of the side wall of a hollow cylinder or drum 35 mounted in the upper portion of the settling compartment for rotation about a vertical axis. While its perforated lower part 34 is immersed in the liquid, the cylinder 35 desirably extends above the liquid level 30 for driving connection to a suitable drive parts shown at 36. With a fixed scraper 37 wiper over the screen 34 to prevent clogging, the cylinder 35, otherwise closed against entry of liquid, is connected internally or on its outlet side to and journaled at the bottom on a suitably bushed or gasketed fixed standpipe 38, through which and an outlet pipe 39 connected to the bottom thereof, the screened product juice entering the cylinder is discharged to the usual boiler house (not shown) for processing for sucrose at a rate controlled by a valve 40 in the outlet pipe.

The mixture of shredded or disintegrated cane or bagasse and dirt from the shredder 14 is fed to the tank 15, suitably by being discharged directly or indirectly from the shredder into a preferably oblique, downwardly and rearwardly inclined or sloping chute 41 along which it slides and is guided or directed to fall into the tank's front end portion. Assisted by the gravity impetus of its fall, the mixed shredded cane and dirt, as it enters and mixes with the liquid juice-cane mixture in the tank, is subjected to a washing action which separates the heavy dirt from the buoyant cane and causes the dirt to settle to the screened bottom 22 of the tank to pass therethrough to the settling compartment 17 and thence to the dirt discharge conveyor 28. However, if, as preferred, there is minimal internal agitation of the liquid mixture in the tank, the washing action therein is not as effective as desired and should be supplemented by washing or rinsing the shredded cane bagasse mixture in advance of the tank. In the illustrated embodiment this is readily accomplished by washing or rinsing the mixture as it moves downwardly along the chute 41 with a spray of rich juice conveniently withdrawn from the upper portion of the settling compartment 17 through an outlet port 42 and applied under force of a suitable circulating pump 43 through a washing juice circulating pipe 44. As the rich juice applied in the chute 41 passes with the cane-dirt mixture into the tank 15 and therefrom to the settling compartment 17, the additional washing actually is effected by recirculating juice without any drain on the supply of rich juice in the casing 3. In the same manner juice can be recirculated through the cane in or in advance of the shredder 14, in this case for adding a scrubbing action to the shredding action of the shredder, as well as to reduce the latter's power requirements.

Constructed in the above manner, the improved apparatus 1 will effectively remove dirt from shredded cane and deliver clean cane to the associated extraction apparatus 2 for processing for juice. Also, by leading or diverting rich product juice from the extraction apparatus to the settling compartment 17, as through the rich juice discharge pipe 7 in the illustrated embodiment, any dirt in that juice will be removed by gravity separation in that compartment for discharge from the bottom thereof by the discharge conveyor 28 through the tube 26. An added advantage of the diversion is that any small particles of fiber and pith in that product juice will be screened out by the screening device 33 before the juice is fed to the boiler house. When so used, the screening device should be shielded from exposure to the incoming product juice before any dirt therein has had a chance to settle, as by an interposed, open-ended shield containing the device and extending from below its bottom to above the juice level 30.

With the properties of removing dirt from the disintegrated cane and screening cane particles from the product juice, the improved apparatus 1 has the following advantages: 1. From dirt removal:

a. Makes possible general use of dry cleaning on mechanically harvested cane with consequent gain in sucrose recovery;

b. Reduces wear on subsequent pumps and machines;

c. Reduces the amount of material required to be processed for juice in the associated extraction apparatus (For example, for a typical initial cane composition of 12-15 percent fiber and 88-85 percent juice, a not unusual dirt content of 4 percent after dry cleaning is equivalent to about 30 percent of the fiber);

d. Eliminates loss of sucrose otherwise attaching to dirt in the final bagasse;

e. Improves boiler operation and prevents fouling of boiler house clarifiers;

f. Improves burning qualities of the final bagasse and prevents slag formation in furnaces.

2. From particle screening:

a. Reduces load on clarifiers.

To the above lengthy list, the displacement rinser 1 of the preferred embodiment adds several other advantages by extracting rich juice from the disintegrated cane received from the shredder 14. In shredding the cleaned cane, the preferred heavy-duty shredder ruptures at least about 90 percent of the juice-containing cells and releases rich juice therefrom, a large part of which then becomes "free" juice loosely held by the fiber. While, in the usual processing line, the extraction apparatus 2, such as the illustrated washing apparatus, is responsible for extracting both the loosely and tightly held juice, the loosely held juice is far more readily extracted and displacement extraction is well suited for the purpose. As described in the above copending application and at length in Appel U.S. Pat. No. 3,248,262, displacement extraction occurs when cane,
previously disintegrated to rupture juice-containing cells, is moved counter a column or front of water or other diluent liquid, in which case the counter-moving liquid acts as a piston to displace and replace the exposed rich juice. The displacement will occur whenever the disintegrated bagasse is passed through a clearly defined displacement interface or interzone formed and maintained between the displacing diluent liquid and displaced rich juice. In the exemplary form of the Appel patent and my copending application these conditions are met by moving a column of disintegrated cane by gravity either vertically or at a steep angle downwardly through a column or pool of water or other diluent liquid. However, the conditions can also be met by mechanically moving or conveying disintegrated cane at a much smaller oblique angle, well below 45°, against a counterflow of diluent liquid, provided the movement of the disintegrated cane is sufficiently gentle and its path sufficiently inclined relative to the horizontal to enable the required clearly defined displacement interface in the path of the cane to be both formed and maintained.

In the illustrated preferred embodiment, displacement extraction of the loosely held juice in the disintegrated cane received in the tank 15 is made possible by lifting the washed cane gently from the tank into and along the discharge trough or compartment 19 at an upward angle sufficient for formation of the required displacement interface, while maintaining static the rich juice level 30 in the tank and supplying the countermoving relatively dilute diluent liquid as a spray applied to the washed cane above and beyond the rich juice level and toward the discharge or outlet end of the trough. While the discharge conveyor 16 may be of any suitable type, the preferred conveyor is a scroll or screw conveyor having a continuous helical scroll or blade 45 perforated throughout its length to pass any otherwise entrained or trapped free liquid without detriment to its movement of the bagasse.

The scroll conveyor 16 desirably extends from the front end of the tank 15 to and beyond the rear or discharge end of the discharge trough 19, conveniently with the leading and trailing end portions of its shaft 46 rotatably mounted or journalled respectively on the bottom panel 21 of the dividing wall 20 and a mounting plate or bracket 47 at the rear end of the casing 18. To support the heavy load imposed on it by the conveyor, the dividing wall 20 suitably is reinforced or stiffened intermediately its ends, as by a corrugated or convoluted reinforcing plate 48 fixed to it above its middle panel which also serves to direct downwardly toward the screened bottom 22 dirt released from cane thereabove in the tank. Suitably U-shaped in transverse cross-section from the dividing wall 20 to the discharge or outlet end of the discharge trough 19, the casing 18 between these extremities has a cylindrically concave, suitably semi-cylindrical bottom wall 49 having as its lower end portion the tank’s screened bottom 22 and of a diameter to receive or accommodate the scroll conveyor 16 up to about the center of the latter’s shaft 46, with the fit therebetween such as to enable the cane to be moved by the conveyor without binding of the latter. In turn, the laterally spaced, substantially parallel side walls 50 of the casing 18 extend upwardly above the liquid level 30 and the scroll conveyor 16 and for reinforcement are outwardly flanged at the top.

With the casing so constructed and both the bottom wall 49 and the discharge trough 19 as a whole disposed obliquely at the same upward slope or inclination as the scroll conveyor-disintegrated cane in the liquid mixture in the tank 15 in the path of the conveyor 16 is lifted thereby from the tank and carried upwardly along the bottom wall 49 to the discharge end of the trough 19. For extracting the loosely held rich juice by displacement from the discharged washed cane dilute or diluent liquid of no or, more preferably, low juice content relative to the rich juice is sprayed on the cane above the liquid level 30 and at a suitable distance therebeyond by a spray head 51 mounted on the casing 18 above the trailing end portion of the discharge trough 19. Axially or longitudinally reciprocable or shiftable parallel to the rotative axis of the scroll conveyor 16, the spray head 51 preferably has a plurality of longitudinally spaced nozzles 52 for directing the diluent liquid into the open top of the trough and onto the discharging washed cane 53 therein. Flowing downwardly along the trough counter the upwardly moving cane carried by the scroll conveyor 16, the relatively dilute or diluent liquid is applied by the spray head 51 at a sufficient rate to saturate the cane above and adjacent the juice level 30 and form therein a diluent liquid plug or front 54 coextensive laterally with the advancing column of cane in that vicinity.

Given slow or gentle upward movement of the cane by the discharge conveyor 16 to avoid turbulence and a sufficient upward inclination, the result is the formation between the dilute or diluent liquid plug 54 and the rich juice in the tank 15 of a displacement interface or more precisely interzone 55 of progressively increasing juice concentration toward the rich juice. With the displacement interface 55 so formed, as the cane moves upwardly therethrough, the loosely held juice therein is displaced and replaced by the diluent liquid, the displaced rich juice adding to the rich juice already in the tank 15, while the replacing diluent liquid is carried off and discharged from the trough 19 with the cane. In performing its function of displacing the loosely held rich juice, the diluent liquid injected by the spray head 51 thus never enters the rich juice in the tank 15, instead initially flowing downwardly through the washed cane substantially to the displacement interface 55 and there reversing direction and moving upwardly with the cane, with the diluent liquid plug 54 and consequently the displacement interface maintained by balancing the input of diluent liquid from the spray head with the outflow in the discharging cane. The longitudinal adjustment of the spray head enables its position to be adjusted to that best suited for maintenance of the interface and spraying of the discharging cane with the diluent liquid has the further salutary effect of washing therefrom any remaining fine particles of dirt for movement by gravity along the bottom wall 49 to and discharge through the tank’s screened bottom 22.

If, as best suited for the maintenance of the displacement interface 55, the rich juice level 30 in the tank 15 is to be substantially static, the continuous addition of rich juice by displacement requires that the rich juice be withdrawn from the apparatus at a corresponding rate and this is controlled by the control or regulating valve 40 in the product juice outlet pipe 39. Also, the scroll conveyor 16 not only must be driven but should be drivable at a variable speed particularly to adjust the washed cane output of the displacement rinsers 1 to the
needs of the associated extraction apparatus 2 and this is accomplished by a variable speed drive 56 conveniently mounted on the casing 18. In turn, the output of washed cane from the displacement rinser needs to be matched with the input of dirty cane from the shredder 14. This is accomplished by continuously sensing the fiber content of the liquid mixture in the tank 15 by a sensing device 57, suitably in the form of a mechanical stirrer mounted for horizontal swinging against yieldable resistance on the top of the tank 15 and having a paddle 58 turning in the liquid mixture in the tank below the liquid level 30. With the torque on its drive predetermined to vary in proportion to variations in the fiber content of the mixture, the stirrer 57 will respond to variations in the fiber content by swinging through a proportional arc and the input of dirty cane is controlled by rheostatically or otherwise suitably applying the changes in the angular position of the stirrer for correspondingly varying the speed of the responsive variable speed drive feed conveyor 10 in advance of the shredder 14. Similarly, when combined with the illustrated extraction apparatus 2, the variable speed drive 56 of the discharge conveyor 16 is made responsive to the height sensing device in the container 3 so as to balance the rate of feed of washed cane to the container with the rate of discharge of cane therefrom which that device also controls.

As indicated earlier, an essential to displacement of juice from disintegrated cane is that the displacement interface through which the cane passes be clearly defined and one of the main factors determinative of such definition is the slope of the path of the cane. This is so because, when the slope is slight relative to the horizontal, the necessarily horizontal interface is dispersed over too large an area to be sharply defined. For a given cross-sectional area of disintegrated cane there is therefore a minimum angular slope or inclination relative to the horizontal below which a clearly defined interface cannot be obtained. In displacement conducted on a laboratory scale on a cane column of small cross-sectional area, the minimum slope can be correspondingly small. However, when, as here, the extraction is conducted on a commercial scale in a juice processing line, the minimum for a clearly defined displacement interface must be greater and, while the 26° upward slope or inclination of the discharge conveyor 16 of the illustrated embodiment is suitable, this is about the minimum that can be tolerated.

Another main factor when the cane is moved by a conveyor is its rate of movement, since the turbulence from too rapid movement would prevent either formation or maintenance of the required clearly defined interface 55. Also, when, as here, the casing 18 does not completely surround the moving cane and therefore cannot have its upper end portion completely filled with diluent liquid, the distance between the point or position at which the diluent liquid is applied to the discharging cane 53 and the rich juice level 30 must be sufficient to afford time for the downwardly flowing liquid to saturate the cane and form the diluent juice plug 54 adjacent the upper side of that level. The preferred embodiment satisfies both of these conditions, with a cane capacity matching that of the illustrated washing apparatus 2, by using a scroll conveyor about 40 ft. long and 5½ ft. in diameter and turning or rotating the conveyor at a speed in a range of from 3–6 r.p.m.

Whatever the type of the associated extraction apparatus, the preferred displacement rinser 1 has the advantage of reducing the load thereon by extracting a large part of the loosely held juice released by the shredder 14. Also, since the rinser 1 is itself capable of extracting juice from disintegrated sugar cane, it is feasible to use a plurality of such rinsers, as the extraction apparatus in a juice processing line, with the rinsers connected in series and the final rinser suitably discharging into a screw press such as disclosed in my co-pending application Ser. No. 65,447, filed Aug. 20, 1970. However, when, as in the exemplary processing line, it is combined with extraction apparatus 2 dependent for effectiveness upon prior disintegration for rupturing juice-containing cells and heating to kill the walls of remaining unruptured cells so that the juice cannot diffuse freely therethrough, it has further advantages which reach a maximum with the illustrated washing apparatus. One, previously mentioned, is the use of the displacement rinser to remove dirt and screen fine cane particles from the rich juice discharged from the sump 6 by leading or directing the rich juice discharge 7 into the settling compartment 17. Another advantage of major importance is that the diluent liquid applied by the spray head 51 can be hot juice obtained by diverting slurry juice to the head through a diverter pipe 60 branching from the slurry juice discharge pipe 8 in advance of the latter's connection to the return pipe 9 leading to the slurry tank 4, with the proportion diverted and thus the quantity injected by the spray head controlled by an automatic valve 61 operatively connected and responsive to a mercury tube and switch or other suitable sensing device 62 also controlling by the diversion the level of the slurry in the slurry tank. With the discharging cane 53 exposed to or retained in the hot diluent liquid for a period of substantial duration (some 3–5 minutes in the preferred embodiment) the cane discharged from the displacement rinser 1 not only will be preheated substantially to the processing temperature in the container 3 of the extraction apparatus 2 but the killing of the cell walls of unruptured cells and diffusion extraction of juice therefrom will have been initiated, with consequent decrease in the load on the extraction apparatus. By discharging the so heated cane from the displacement rinser 1 directly into the slurry tank 4, as through a discharge spout 63, for mixing with the heated slurry therein, the process heat diverted from the container 2 to the displacement rinser is substantially conserved. Too, a further and large conservation of process heat is brought about by the removal of the relatively cool displaced rich juice from the extraction process before any heat is applied to the disintegrated cane.

A juice processing line such as that illustrated, in which the extraction apparatus 2 is washing apparatus of my co-pending application, can readily process cane at a high rate and even when operating conservatively will process over 120 tons per hour. The displacement rinser 1 of course must have comparable capacity, since all of the disintegrated cane passes through it and one size with variable capacity will suit most installations. As explained earlier, the action of the displacement rinser in removing dirt from the disintegrated cane is most effective when the cane is rinsed with recirculated rich juice in advance of the tank 15, conveniently in the chute 41. The rate at which the juice is
applied will vary with the rate of input of the disintegrat-
ed cane and also with the latter's dirt content, but usu-
ally will be in the range of from 2,000 to 3,000 g.p.m.
The rate at which screened rich product juice is with-
drawn through the outlet pipe 39 for processing for su-
crose in the boiler house also will vary with the input rate of the disintegrated cane, with the range in its case
usually from 200 to 400 g.p.m. The other liquid vari-
able within the displacement riner is the rate at which the preferred hot slurry juice is applied to the discharg-
ing cane through the spray head 51 and for a conserva-
tive cane input rate of about 120 tons per hour usually
will be somewhat over 1,000 g.p.m.

From the above detailed description it will be appar-
ent that there has been provided improved apparatus
for treating disintegrated cane which is adapted not
only to remove dirt from shredded cane without loss of
juice but also to extract loosely held rich juice, with nu-
erous advantages to subsequent processing of the
cane for juice and also of the juice for sucrose. It should
be understood that the described and disclosed em-
bodyment is merely exemplary of the invention and that all
modifications are intended to be included that do not
depart from the spirit of the invention and the
scope of the appended claims.

Having described my invention, I claim:
1. Apparatus for removing dirt from disintegrated
sugar cane, comprising a tank containing sugar juice
for receiving said cane and washing dirt therefrom for
gravity settlement to a bottom of said tank, means con-
ected to the bottom of said tank for receiving dirt and
juice therefrom and including upwardly sloping con-
voyeur means for separately discharging dirt from
said juice, screening means in the connection between
said tank and connected means for passing dirt and
juice from said tank while substantially retaining said
cane therein, and means for separately discharging
washed cane from said tank.

2. Apparatus according to claim 1, including means
for controlling the cane content of the juice in the tank.

3. Apparatus according to claim 2, wherein the con-
trolling means includes sensing means exposed to said
juice, and variable speed conveyor means responsive in
speed to said sensing means and positioned in advance
of the tank for varying the rate of feed of cane thereto-
ward.

4. Apparatus according to claim 1, wherein the
washed cane discharging means includes a cane dis-
charge compartment open to and extending at an up-
ward slope from the tank, and a discharge conveyor ex-
tending downwardly into the tank and upwardly at a
corresponding slope through said discharge compart-
ment for discharging washed cane from an open upper
end thereof.

5. Apparatus according to claim 4, wherein the juice
in the tank is rich juice maintained at a static level
therein, and including means for applying relatively di-
lute liquid above said rich juice level to washed cane
discharging through the discharge compartment for
forming a plug of said dilute liquid adjacent and above
said level, said upward slope of said discharge compart-
ment and conveyor being sufficient to enable a clearly
defined displacement interface to be established be-
tween said plug and level and across the path of the dis-
charging cane for extracting loosely held rich juice by
displacement from cane passing therethrough.

6. Apparatus according to claim 5, wherein the mini-
imum upward slope of the discharge compartment and
conveyor is about 26°.

7. Apparatus according to claim 5, wherein the dis-
charge conveyor is of substantially uniform upward
slope over the length thereof, and the tank has a corre-
spondingly sloping bottom wall along which the dis-
charge conveyor extends substantially to a front end
wall of said tank remote from the discharge compart-
ment.

8. Apparatus according to claim 7, wherein the
screening means is coarse screening in the bottom wall
of the tank.

9. Apparatus according to claim 8, wherein the dilu-
ent juice applying means is a spray head shiftable longi-
tudinally of the discharge compartment, and the dilu-
ent juice sprayed from the spray head rises fine dirt
particles from the discharging cane for movement
downwardly along the discharge compartment and
tank to the coarse screening in the bottom wall of the
tank.

10. Apparatus according to claim 9, wherein the dis-
charge conveyor is a scroll conveyor having a continu-
os perforated blade for discharging cane and passing
free liquid, and the tank and discharge compartment
have a continuous cylindrically concave bottom wall
receiving said scroll conveyor.

11. Apparatus according to claim 10, including an
upwardly opening casing containing the tank and dis-
charge compartment, a settling compartment con-
tained in said casing and connected to the bottom of
the tank through the coarse screening for receiving the
upwardly sloping dirt and juice therefrom, dirt dis-
charge conveyor means is open to a bottom of said set-
tling compartment for discharging dirt therefrom with-
out substantial loss of juice therewith, and a screening
device in an upper part of said settling compartment
and connected on an outlet side to a rich juice outlet
line for screening fine cane particles from rich juice dis-
charged therethrough.

12. Apparatus according to claim 11, including a
control valve in the rich juice outlet line for controlling
the rate of discharge of rich juice therethrough and
thereby the static level of rich juice in the tank, and
means for rinsing the disintegrated cane with rich juice
from said settling compartment in advance of the tank
for supplementing the dirt washing action therein.

13. Apparatus according to claim 11, wherein said
connected means includes a settling compartment con-
taining sugar juice for gravity separating dirt and juice
received therein, and means for discharging said juice
separate from said dirt.

14. Apparatus according to claim 13, including
means for rinsing the disintegrated cane with juice in
advance of the tank for supplementing the dirt washing
action therein.

15. Apparatus according to claim 14, wherein the
rinsing juice is recirculated juice pumped from said
compartment and returned thereto through the tank.

16. Apparatus according to claim 15, wherein the
juice in said tank and compartment is rich juice.

17. Apparatus according to claim 13, wherein the up-
wardly sloping dirt discharge conveyor means includes
tube means open to and leading upwardly from a bot-
tom of said compartment above the level of juice
therein, a conveyor in said tube means for discharging
dirt therefrom through an open upper end thereof, and
means for washing said dirt with water prior to discharge thereof for preventing substantial loss of juice therewith.

18. Apparatus according to claim 17, wherein the conveyor is an endless conveyor discharging said dirt by a lower flight thereof, and including a plate in said tube means and covering an intermediate portion of said lower flight for containing and restraining downward movement of the wash water.

19. Apparatus according to claim 17, wherein the juice discharge means includes a fine screening device in an upper part of said compartment for screening fine particles of cane from said juice, and an outlet line connected to an outlet side of said screening device and having a control valve therein for controlling the rate of discharge of the screened juice.

20. Apparatus according to claim 19, wherein the screening device includes a hollow cylinder rotatable about a vertical axis and having a finely perforated lower part immersed in the rich juice for screening the fine cane particles, and a fixed scraper wiping over said lower part for preventing clogging thereof.

21. Apparatus for rinsing juice from disintegrated sugar cane, comprising a tank filled to a static level with rich sugar juice for receiving said disintegrated cane, upwardly sloping conveyor means for lifting said cane from said rich juice and above the level thereof discharging said cane along a correspondingly sloping path from said tank, and means for rinsing said discharging cane between an outlet end of said conveyor means and said rich juice level with liquid dilute relative to said rich juice for forming a plug of said dilute liquid adjacent and above said level, said conveyor means so upwardly sloping as to enable a clearly defined displacement interface to be established between said plug and level and across the path of the discharging cane for extracting loosely held rich juice by displacement from cane passing therethrough.

22. Apparatus according to claim 21, wherein the conveyor means slopes upwardly from the tank at a slope relative to the horizontal in a range of from about 25° to about 45°.

23. Apparatus according to claim 22, including means for controlling the cane content of the juice in the tank.