

[54] **DRY CANE CLEANING AND SPREADING**

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[56] **References Cited**

UNITED STATES PATENTS

2,210,103 8/1940 Stoner.....209/135 X

2,941,667 6/1960 Hilgartner et al.....209/134

3,358,830 12/1967 Duncan.....209/136 X

1,962,668 6/1934 Olney209/136

3,164,548 1/1965 Rowell et al209/153 X

FOREIGN PATENTS OR APPLICATIONS

557,181 11/1943 Great Britain209/134

568,024 10/1957 Italy209/136

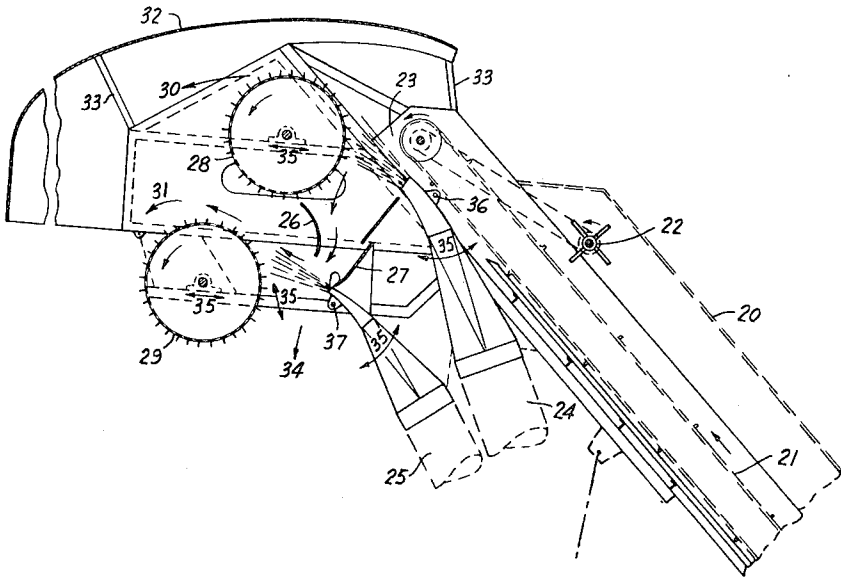
537,987 4/1922 France209/149 X

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[57] **ABSTRACT**

Apparatus for spreading harvested sugar cane pieces and for dry separating the extraneous matter from the cane, comprising means for spreading the cane to effect frictionally a slight dissociation of the extraneous matter from the cane; means for forming the cane into a falling curtain; means for providing a low-velocity air jet to intercept transversely the falling curtain of cane and separate therefrom a low-density fraction of extraneous matter (for example, leaves); means for subsequently providing a high-velocity air jet to intercept transversely the falling curtain of cane and separate therefrom a generally higher density fraction of extraneous matter (for example, tops); the final separation being enhanced by the provision of means for imparting a horizontal component of velocity to the cane before it is intercepted by the high-velocity air jet.

6 Claims, 3 Drawing Figures



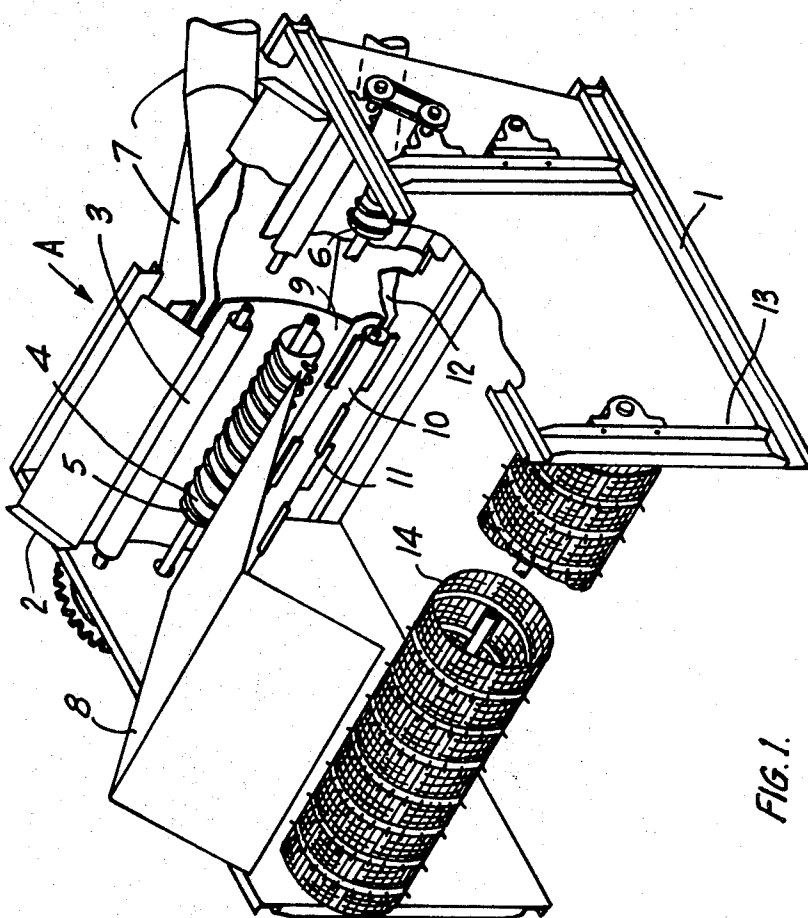
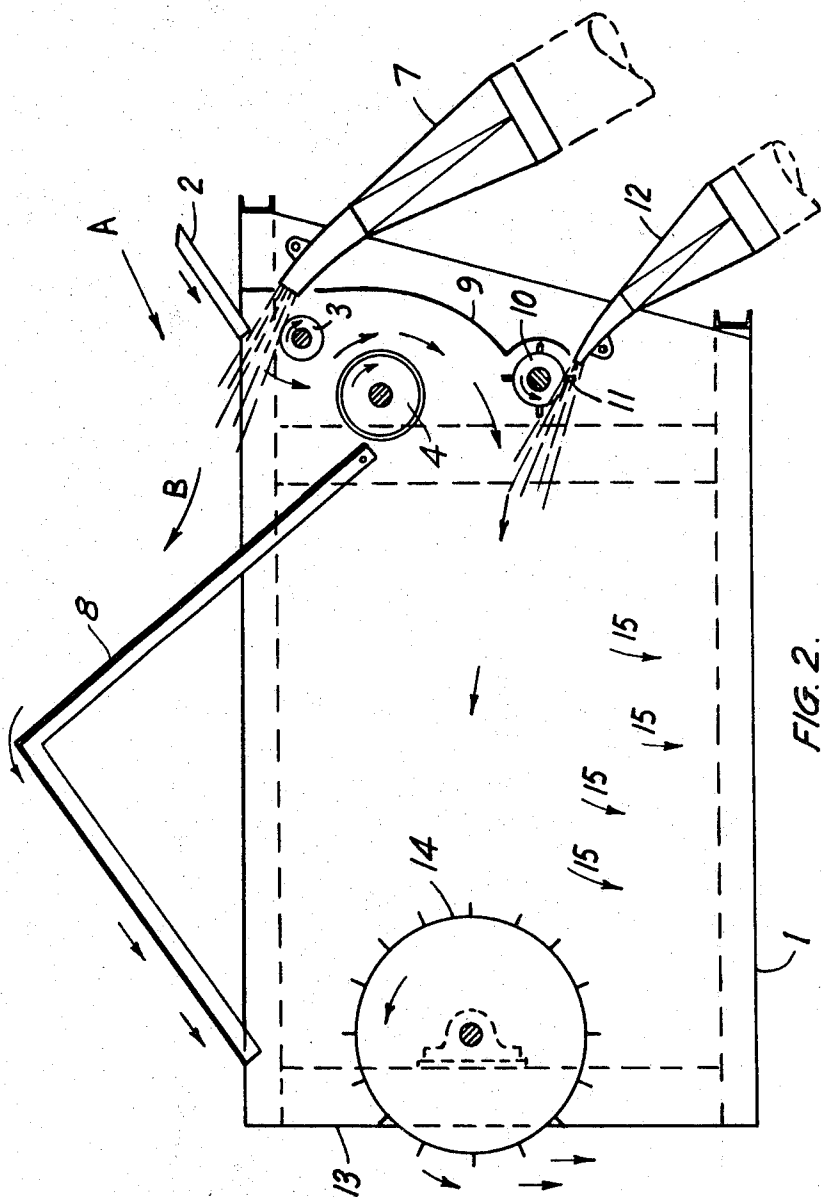


FIG. 1.

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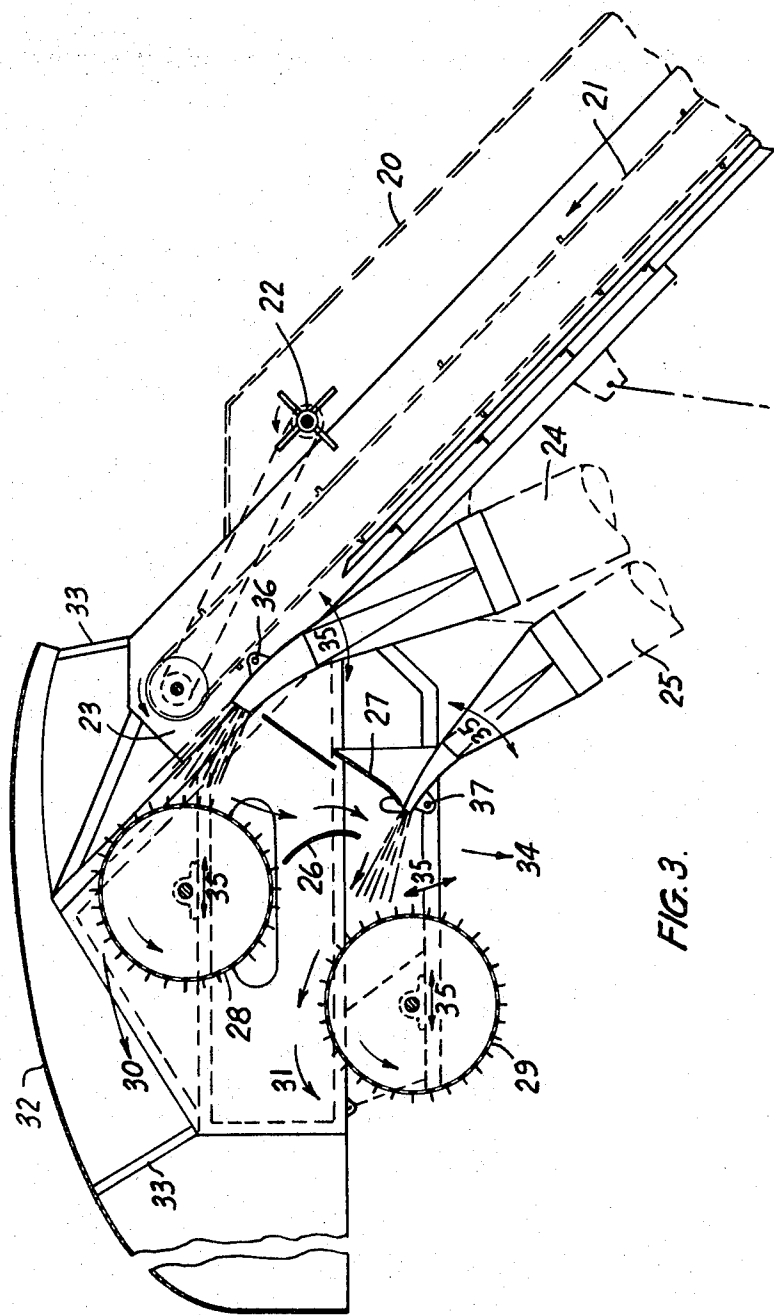


FIG. 3.

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DRY CANE CLEANING AND SPREADING

This invention relates to apparatus for spreading harvested sugar cane pieces and for dry separating the extraneous matter from the cane.

Harvested cane comprises a significant proportion of extraneous matter having a very low sugar content—for example, tops, trash (leaves), side shoots, suckers—and it is therefore preferable to separate this commercially valueless matter from the cane before processing in the sugar mill. Harvested cane additionally comprises some extraneous matter having no sugar content at all—for example, stones dirt and weeds—and this actively interferes with the efficient separation of sugar juice from the cane during mill processing.

In some of the mechanical harvesters currently in use, means are provided for cutting the cane into short lengths and air separation means are included for then removing a portion of the low density fraction of extraneous matter. The partly cleaned cane is then allowed to fall into the collecting bin of a vehicle moving alongside or behind the harvester (this vehicle is referred to hereinafter as a "buggy"), and may be transported therein—or in another vehicle—directly to the mill for processing. If the cane is considered to require secondary cleaning before mill processing, it is first transported to a nearby transloader. The latter piece of equipment transfers the cane from the buggy to a stationary dry cleaning unit in which an additional separation of the remaining extraneous matter is carried out, the cane then being sent to the mill.

The leaves in particular, by virtue of their relatively low density, are well suited for separation from the cane by air separation means, but in the mentioned harvesters presently available the total mass of cane and extraneous matter is presented to the mentioned air separation means thereof in such an entangled condition that very little trash separation is achieved at this point. For this reason, if maximum removal of extraneous matter is required, considerable reliance must be placed on subsequent cleaning steps.

It is an object of the present invention to provide apparatus for dry separating the extraneous matter from harvested sugar cane pieces more efficiently than has heretofore been possible.

It is a further object of the invention to provide versatile such apparatus which can be incorporated in a mobile unit (for example, a sugar cane harvester or buggy) or in a stationary cane-cleaning unit, or which can be assembled as required from components in two units (for example, assembled from components in a transloader and a juxtaposed stationary cane-cleaning unit).

When the apparatus is incorporated in a sugar cane harvester or in a buggy, it will be appreciated that the need to provide secondary cleaning in a stationary cane-cleaning unit can be reduced or eliminated, and the total process of harvesting and cleaning can then be accelerated.

When the apparatus is incorporated in a buggy there is an ancillary advantage, namely that the cane falling into the collecting bin thereof can be more evenly spread therein than has heretofore been possible except by manual means or by moving the buggy relatively to the harvester during harvesting.

The invention is based on two findings.

The first finding is that the final removal of extraneous matter from the cane by air separation is much facilitated by effecting frictionally a preliminary slight dissociation of the extraneous matter from the cane. Most conveniently, and as described herein, this preliminary slight dissociation is achieved by submitting the cane to a spreading movement.

The second finding is that when—as is usual—the extraneous matter comprises both low density and high density components (for example, leaves and tops respectively), the air separation technique is best applied in a sequence of two stages—(i) a stage wherein a low velocity air jet is used to separate low density extraneous matter from the cane, and (ii) a stage wherein a high velocity air jet is used to separate residual, generally higher density extraneous matter from the cane.

According to the invention, apparatus is provided for spreading harvested sugar cane pieces and for dry separating the associated extraneous matter from the cane, comprising:

- a. means for spreading the cane, whereby also effecting frictionally a preliminary slight dissociation of the extraneous matter from the cane;
- b. means for forming the cane into a first falling curtain, the longitudinal dimension thereof of said curtain-forming means being greater than its dimension transversely thereof;
- c. low velocity air jet means for transversely intercepting the cane in said first falling curtain, whereby to separate therefrom a first (low density) fraction of extraneous matter and to impart preferentially to said first fraction a horizontal component of velocity;
- d. means for forming the cane into a second falling curtain, the longitudinal dimension thereof being greater than its dimension transversely thereof and said and, for imparting to said second falling curtain a horizontal component of velocity in a given direction;
- e. high velocity air jet means for transversely intercepting the cane in said second falling curtain, whereby to separate therefrom a second (generally higher density) fraction of extraneous matter and to impart preferentially to said second fraction an additional horizontal component of velocity in said given direction;
- f. means for removing the separated first and second fractions of extraneous matter, whereby to prevent the reassociation thereof with the cane;

the arrangement being such that, in operation, the cane is submitted to the spreading means at least before being intercepted by the high velocity air jet.

Preferably the cane is submitted to the spreading means before being intercepted by the low velocity air jet.

As a matter of practical convenience, the low and high velocity air jet means are preferably arranged to provide air jets having horizontal components of velocity in the same (given) direction.

The spreading means can be provided in some cases by existing equipment. For example, a transloader is normally provided with a conveyor having a "levelling" device at the upper (discharge) end thereof, and this levelling device functions effectively as a means for spreading the cane and for simultaneously effecting a preliminary slight dissociation of the extraneous matter from the cane. It will be appreciated therefore that total apparatus according to the invention can readily be developed by modifying a transloader to incorporate additionally the defined two stage air separation means (as in embodiment 2 hereinafter), or alternatively the transloader can be associated with a separate cane cleaning unit for effecting this two stage air separation.

In other cases, the spreading means is provided by separate equipment. Suitable such separate equipment consists of the horizontally disposed spreading rollers to be described fully hereinafter in relation to embodiment 1. These spreading rollers have the advantage also of thinning the curtain of cane transversely so as more effectively to apply the air separation means thereto.

Broadly speaking, the air separation system envisaged herein is a "winnowing" system designed to separate extraneous matter from a falling curtain of cane by using the air jet means to impart a greater horizontal velocity to the extraneous matter than to the cane. In the first separation stage, the density differential between the low density extraneous matter (for example, light trash) and the cane is so great that horizontal separation of the former from the falling curtain can easily be accomplished by an intercepting air jet. However, in the second separation stage, the density differential between the residual high density extraneous matter (for example, tops) and the cane is less pronounced, and in this case—in spite of using an air jet of higher velocity—it has been found essential to impart a "booster" horizontal velocity to the falling curtain of cane before it is intercepted by the air jet. The means

designated as (d) above is designed therefore to facilitate the final air separation of heavier extraneous matter from the cane.

Suitably, the booster horizontal velocity can be imparted to the curtain of cane by means of a horizontally disposed throwing roller and/or by making use of a horizontally inclining deflector sheet.

It will be appreciated that the terms "low" and "high" velocity air jets as used herein relate to air jets having with respect to each other relatively low and relatively high velocities. In practice, it has been found that the velocities of suitable low velocity and high velocity air jets for achieving a two-stage air separation according to the invention are respectively of the order of 100 and 200 feet/second.

It has been found commercially expedient to provide a falling curtain of cane having a transverse thickness of about 3 to 4 inches, and in this case it has been found suitable to provide each air jet means with air at a volume rate of the order of 10,000 cubic feet/minute.

It can be calculated easily that, to achieve the mentioned velocities of 100 and 200 feet/second from an air supply at the mentioned volume rate of 10,000 cubic feet/minute, the cross-sectional areas of the air jets at their points of discharge must be about 1.67 and 0.84 square feet respectively.

The air issuing from an air jet rapidly becomes diffuse and loses energy with increasing distance from the point of discharge. It is desirable therefore to present the cane to the air jet within a distance as short as possible from its point of discharge. Preferably, the air jet is caused to intercept the curtain of cane within about 6 inches from its point of discharge.

The degree of horizontal separation which can be achieved according to the invention between the separated extraneous matter and the cane at either air separation stage is clearly a function of many interrelated factors, including: (i) the nature of the cane, (ii) the size of the cane pieces, (iii) the nature of the extraneous matter, (iv) the velocity and volume of the air at the point of interception, and (v) the velocity and transverse thickness of the curtain of cane at the point of interception.

It is clearly necessary to position the means for removing the extraneous matter appropriately with regard to the degree of horizontal separation that can be achieved at either air separation stage, and the optimum position for these means will depend on the mentioned factors in each case. Failure to observe these principles will tend to result in an unsatisfactory separation of extraneous matter from the cane and/or a reassociation of such matter with the cane.

So that allowance can be made as appropriate for variation in the mentioned factors, it is desirable to arrange for the means comprising the apparatus to be adjustable as regards their relative disposition and orientation.

Suitable means for removing the separated extraneous matter from the cane can be of various kinds, including stationary deflector sheets and/or rotating drums with solid or perforated surfaces. The use of both a stationary deflector sheet and a rotating drum is illustrated in embodiment 1 discussed hereinafter. In a preferred arrangement, illustrated in embodiment 2 discussed hereinafter, the means provided comprise rotating drums whose surfaces are constituted by coarse wire mesh ($\frac{3}{4}$ -inch square) and which are upwardly moving at the site of contact with the separated extraneous matter. Trash is readily pinned to such a surface by an air jet, and the upward movement of the surface then positively carries it through a semicircular path away from the cane. At the end of this path the trash is readily detached from the drum—for example, it falls off or may be assisted to fall off by the residual air jet passing through the interior of the drum. When high density extraneous matter is involved it is advantageous to include spike projections on the surface of the drum to assist in pinning such matter thereon.

Two embodiments of the invention are now discussed with reference to the appended drawings in which

FIG. 1 is a perspective view with parts broken away of the apparatus according to embodiment 1 supported by a frame, the latter being adapted for mounting above the collecting bin of a buggy (not shown);

FIG. 2 is a cross-sectional side elevation of the same apparatus and supporting frame;

FIG. 3 is a cross-sectional side elevation of the apparatus according to embodiment 2 incorporated in a transloader at its discharge end.

Referring now to FIGS. 1 and 2, the apparatus according to embodiment 1 is supported by a frame 1, which—in use—is mounted above the collecting bin of a buggy. The buggy moves alongside or behind a cane harvester, and harvested cane pieces are discharged towards the collecting bin from the general direction A. A chute 2 is provided which extends longitudinally across the frame, and the cane is formed thereon into a first falling curtain whose dimension parallel to said chute is much greater than its thickness. Typically, the first curtain of cane has dimensions of the order of 3 feet long and 1 foot wide.

A pair of horizontally disposed "spreading" rollers 3, 4 with parallel longitudinal axes is provided below the chute, and these rollers provide means for spreading the cane in opposite directions longitudinally of said rollers.

The axes of the rollers are somewhat displaced from each other in the vertical sense, the pair thus consisting of an upper roller 3 and a lower roller 4.

As shown, the lower roller is preferably of larger diameter than the upper roller and, relative to the latter, it is inwardly positioned above the collecting bin. Typically, the lower roller has a diameter of about 9 inches, the upper roller has a diameter of about 4½ inches, and the shortest distance between their surfaces is about 3 inches.

Both rollers rotate in the same direction about their axes, and it will be seen that this direction is selected in such a way that the lower roller tends to assist the passage of pieces of cane through the nip between the rollers, while the upper roller tends to prevent such passage.

At least the lower roller is adapted to function as a nonpositive auger feed and for this purpose is provided along the two halves of its length from the middle thereof with flangelike oppositely oriented helices 5, 6. The helix 5 along one half from the middle of the roller is "left hand", and the helix 6 along the other half from the middle of the roller is "right hand". The relative disposition of the helices is such that cane pieces when fed to the rollers at a site half way along their length are distributed frictionally along the helices toward both ends of the lower roller before passing through the nip.

An air duct 7 is provided, and is adapted to discharge a low velocity air jet transversely towards the first curtain of cane falling between the chute and the spreading rollers. This serves to impart a horizontal component of velocity preferentially to a low density fraction of extraneous matter (especially loose trash), and—as shown—this is then blown upwardly and across the buggy in the general direction B.

This separated matter is prevented from falling into the collecting bin by means of a suitably shaped cowl 8 which slopes upwardly from adjacent the lower roller and extends to a distance as required across the bin. The region of the cowl adjacent the lower roller also functions to deflect the batch of cane towards the nip between the rollers and to prevent it also from falling directly into the bin.

Pieces of cane passing through the nip between the spreading rollers have been spread longitudinally of the rollers in a horizontal plane (for example, to a length of 6 feet) and now fall in a second curtain of reduced thickness (for example, 3 inches) via a horizontally inclining deflector sheet 9 towards a rotating throwing roller 10. The axis of the throwing roller is parallel to the axes of the spreading rollers, and the surface thereof is equipped with a series of longitudinal vanes 11 whose radial extent is sufficient positively to make impact with the pieces of cane. The speed and direction of rotation of the roller being appropriate therefor, this serves to impart a

horizontal component of velocity to the pieces of cane, thereby assisting to throw them transversely across the frame.

An air duct 12 is positioned below the throwing roller and is adapted to discharge a high velocity air jet to intercept transversely the horizontally directed second falling curtain of cane, and to impart an additional horizontal velocity preferentially to the generally higher density fraction of extraneous matter associated with the cane.

This high velocity air jet captures most of the residual low density extraneous matter and carries it upwardly transversely out of the frame at the longitudinal side 13 thereof. The cowl is suitable dimensioned above the latter side of the frame to allow this removal to be achieved.

As shown, a rotating "top remover" roller 14, with axis also parallel to the previously mentioned axes, is provided on side 13 of the frame. The surface of the top remover roller is equipped with a number of spikes which serve (the speed and direction of rotation of the roller being appropriate therefor) to facilitate the removal of the heavier extraneous matter (especially tops) which otherwise might not be carried completely away from the bin by the high velocity air jet. Conveniently, as shown, the surface of this roller consists of coarse wire mesh (1 square inch). inch)

The relatively higher density cleaned pieces of cane are given variable trajectories by the throwing roller 10 and fall in various paths 15 towards the floor of the collecting bin below. The cane has already been spread longitudinally of the spreading rollers, and the action of the throwing roller serves to effect spreading transversely thereof. The cleaned cane can thus be collected evenly in the collecting bin of the buggy.

Referring now to FIG. 3, the apparatus according to embodiment 2 is shown incorporated in a transloader 20 at the discharge end thereof (which only is illustrated).

In the normal functioning of the transloader, cane is transported by means of conveyor 21 to a rotating tined levelling device 22, which serves to spread and thin the mat of cane to a substantially uniform depth of about 3 to 4 inches. The transloader conveyor has a width typically of about 6 feet, so that the cane is discharged at 23 as a (first) falling curtain having very suitable dimensions for cleaning in accordance with the invention.

In embodiment 2, the complementary apparatus according to the invention is attached to the discharge end of the transloader, however it will be appreciated that the overall dimensions of the thus modified transloader are very great, and for this reason in practice it may often be preferred to incorporate said complementary apparatus alternatively in a separate juxtaposed unit of equipment.

As shown, air ducts 24 and 25 are adapted to discharge respectively low and high velocity air jets transversely towards the falling curtain of cane, at the discharge end of the transloader. The functions of these air jets have already been described and the description is not here repeated.

In consequence of interception by the low velocity air jet, the curtain of cane becomes somewhat spread in the direction of air jet flow, and deflector sheets 26 and 27 are therefore located as shown to form the cane into a second falling curtain of appropriately narrow thickness for presenting to the high velocity air jet. Deflector sheet 27 is horizontally inclining and serves additionally to impart a (booster) horizontal component of velocity to the cane before the latter is intercepted by the high velocity air jet. It will be seen that, in this embodiment, deflector sheet 27 is the only means provided for imparting this horizontal component of velocity to the cane. As shown, this deflector sheet is attached to air duct 25, but it can of course, be entirely separate.

As described previously, the means provided in this embodiment for removing the two fractions of extraneous matter after separation by the low and high velocity air jets comprise rotating drums 28 and 29 respectively, whose surfaces are constituted by coarse wire mesh ($\frac{1}{4}$ -inch square). The general directions by which the separated fractions of extraneous matter are removed from possible reassociation with the cane are indicated by arrows 30 and 31.

A closed canopy 32 having top and sides, and supported by struts 33, is provided above the apparatus for the purpose of containing the air jets and restricting the path of the separated fractions of extraneous matter.

The cleaned cane in this embodiment has a less variable trajectory than in the case where a throwing roller is employed, and falls in a generally confined path indicated by 34. Conveniently, the cleaned cane can be collected in a truck underneath.

Means are provided in this embodiment for adjusting the relative disposition of air duct 24, air duct 25 and attached deflector sheet 27, rotating drums 28 and 29, and the possible movements of these components are indicated by double-ended arrows 35, 36 and 37 are pivot points about which air duct 24 and air duct 25 (with deflector sheet 27) can move.

As discussed hereinbefore, these means are provided to accommodate variations in the mentioned factors (i) to (v).

While the invention has been described particularly in relation to two embodiments only, it will be appreciated from the general discussion given herein that the invention can be realized in a number of other embodiments all falling within the scope of the appended claims.

I claim:

1. Apparatus for spreading harvested sugar cane pieces and for dry separating the associated extraneous matter from the cane, said apparatus comprising:

- a. means for spreading the harvested cane and thereby frictionally effecting a slight dissociation of the extraneous matter from the cane;
- b. means for forming the cane after said spreading into a first falling curtain having a width greater than its thickness;
- c. low velocity air jet means for directing a current of air to transversely intercept the cane in said first falling curtain and separate therefrom a first low density fraction of extraneous matter and to impart preferentially to said first fraction a horizontal component of velocity;
- d. means for forming the cane, after separation of said first fraction, into a second falling curtain having a width greater than its thickness, and for imparting to said second falling curtain a horizontal component of velocity in a given direction;
- e. high velocity air jet means for directing a current of air to transversely intercept the cane in said second falling curtain, separate therefrom a second generally higher density fraction of said extraneous matter, and impart preferentially to said second fraction an additional horizontal component of velocity in said given direction; and
- f. means for removing the separated first and second fractions of extraneous matter to prevent the reassociation thereof with said cane.

2. Apparatus according to claim 1 in which said means (d) for forming the cane into a second falling curtain having a horizontal component of velocity include a deflector sheet, said deflector sheet curving progressively toward the horizontal at its lower end.

3. Apparatus according to claim 1 in which said means (f) for removing separated extraneous matter comprise a horizontally disposed rotating drum having a surface of coarse wire mesh, said drum being so positioned with respect to a said air jet means that extraneous matter separated by an air jet therefrom can be pinned to said surface by the said air jet, the direction of rotation of said drum being such that said pinned extraneous matter is then carried upwardly away for discharge.

4. Apparatus for spreading harvested sugar cane pieces and for dry separating the associated extraneous matter from the cane, comprising:

- a. means for forming the cane into a first falling curtain, the width of which is greater than its thickness;
- b. low velocity air jet means for transversely intercepting the cane in said first falling curtain, whereby to separate therefrom a first (low density) fraction of extraneous

matter and to impart preferentially to said first fraction a horizontal component of velocity;

c. means for spreading the cane after separation of said first fraction, whereby also effecting frictionally a slight further dissociation of extraneous matter from the cane;

d. means firstly for forming the cane after spreading into a second falling curtain, the width of which is greater than its thickness, and secondly for imparting to said second falling curtain a horizontal component of velocity in a given direction;

e. high velocity air jet means for directing a current of air to transversely intercept the cane in said second falling curtain, separate therefrom a second generally higher density fraction of said extraneous matter, and impart preferentially to said second fraction an additional horizontal component of velocity in said given direction; and

f. means for removing the separated first and second fraction of extraneous matter to prevent the reassociation thereof with said cane.

5. Apparatus according to claim 4 in which said means (c) for spreading the harvested cane comprise a pair of vertically

spaced horizontally disposed rollers having a nip therebetween, the axes of said rollers being transversely spaced and parallel, said rollers being adapted for rotation in the same direction about said axes, said direction being such that the lower roller tends to assist the passage of pieces of cane through said nip but the upper roller tends to prevent such passage, and at least the lower roller having a flangelike left-hand helix extending lengthwise from the middle thereof toward one end and a flangelike right-hand helix extending lengthwise from the middle thereof toward its other end, said helices being adapted to function as a nonpositive auger feed for spreading the cane lengthwise and horizontally in opposite directions from said middle.

6. Apparatus according to claim 4 in which said means (d) for forming the cane into a second falling curtain having a horizontal component of velocity include a horizontally disposed throwing roller, the surface thereof being equipped with a series of longitudinal vanes for making impact with the pieces of cane and imparting thereto a horizontal component of velocity.

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