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(54) A device and method for removing a foreign object from harvested leaves

(57) A device for removing a foreign object from harvested leaves, the foreign object being more dense than each leaf in the harvested leaves, the device comprising: an input feed conveyor (105)operable to receive the harvested leaves; a second conveyor (110) having a plurality of holes which allow air to flow therethrough and being separated from the input feed conveyor (105) by a gap; a suction device (120) operable to suck air through a first area of the second conveyor (110), the suction being sufficient to draw the harvested leaves from the input feed conveyor (105) onto the second conveyor (110) whilst leaving the foreign object on the input feed conveyor (105); and an output (135) separated from the input conveyor (105) by a second gap bridged by the first area of the second conveyor (110), where the output (135) is located below a second area of the second conveyor (110), wherein the suction device (120) is operable to lose sufficient suction at the second part of the second conveyor (110) so that the harvested leaves fall from the second conveyor (110) to the output (135).

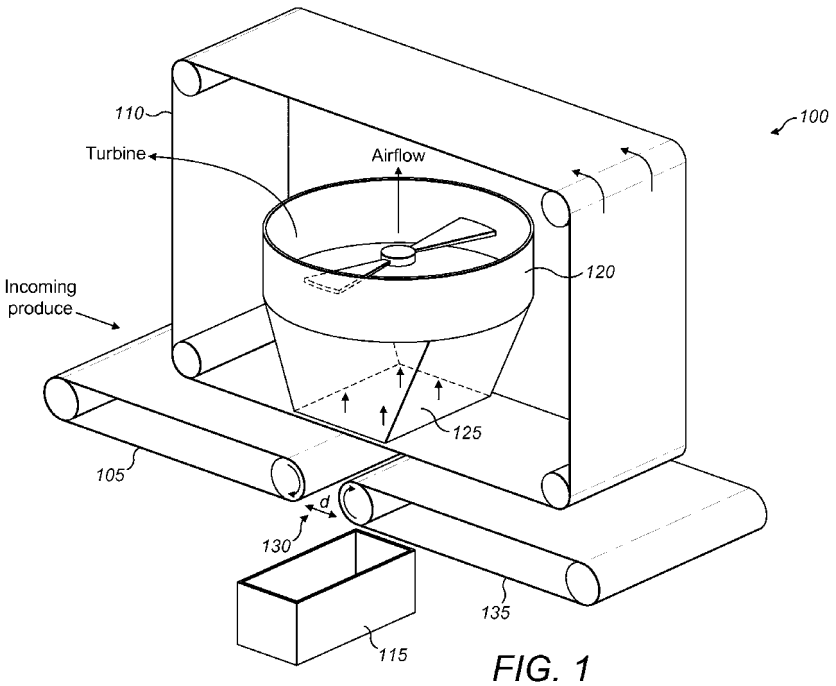

FIG. 1

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Description

[0001] The present invention relates to a device and method for removing a foreign object from harvested leaves.

[0002] During harvesting of leafed products such as salad leaves, foreign objects such as mice, frogs crickets and grasshoppers can be harvested along with the leaves. These are hard to wash from the leaves so that when subsequently processed and bagged ready for sale in stores, the foreign object can mistakenly be included in the bagged salad. This is undesirable.

[0003] It is an aim of the present invention to provide a device and method which reduces the likelihood of a foreign object being included in the bagged product.

[0004] According to a first aspect, there is provided a device for removing a foreign object from harvested leaves, the foreign object being more dense than each leaf in the harvested leaves, the device comprising: an input feed conveyor operable to receive the harvested leaves; a second conveyor having a plurality of holes which allow air and debris from the harvested leaves to flow therethrough and being separated from the input feed conveyor by a gap; a suction device operable to suck air through a first area of the second conveyor, the suction being sufficient to draw the harvested leaves from the input feed conveyor onto the second conveyor whilst leaving the foreign object on the input feed conveyor; and an output separated from the input conveyor by a second gap bridged by the first area of the second conveyor, where the output is located below a second area of the second conveyor, wherein the suction device is operable to lose sufficient suction at the second part of the second conveyor so that the harvested leaves fall from the second conveyor to the output

[0005] This is advantageous because foreign objects that are more dense than the leaves fall through the second gap. This movement of the leaves from one conveyor to a second conveyor removes objects denser than the leaves from the harvested leaves. This is because density is a measure of weight or mass per unit volume. Therefore, a heavy object having a large surface area may be sucked onto the second conveyor whereas a less dense object having a small surface area may be left on the input conveyor. Additionally, as the mesh is sized to let debris flow therethrough, the harvested leaves are also partly cleaned as they pass along the second conveyor.

[0006] The output may be either an output conveyor or a hopper.

[0007] The second conveyor may be positioned above the input feed conveyor.

[0008] The suction device is a fan located directly above the first part of the second conveyor.

[0009] The suction device may be a fan having an input connected to ducting at one open end, whereby the other open end of the ducting extends along the first part of the second conveyor.

[0010] The suction device may have variable suction power provided by a variable speed fan.

[0011] The suction device may have variable suction power provided by a variable sized opening along the length of the ducting.

[0012] The other open end of the ducting may be connected to a suction head having a rubber seal provided between the suction head and the second conveyor.

[0013] The second conveyor may be made from plastic mesh.

[0014] A harvester comprising a picking device to harvest leaves and a device according to either the first or second embodiment may be provided.

[0015] Various other features and embodiments are provided in the appended claims.

[0016] Embodiments of the present invention will be described, by way of example only, with reference to the following drawings, in which:

Figure 1 shows a first embodiment of the device for removing a foreign object from harvested leaves;
Figure 2 shows a second embodiment of the device for removing a foreign object from harvested leaves;
Figure 3 shows a harvester including a device for removing a foreign object from harvested leaves according to either the first or second embodiment;
Figure 4 shows a harvester arrangement with an agitating conveyor belt according to the prior art; and
Figure 5 shows a harvester arrangement of another embodiment of the present invention.

[0017] Referring to Figure 1, a device 100 according to a first embodiment of the present invention is shown. Harvested leaves such as spinach leaves, rocket leaves or any kind of leafed product are fed into an input conveyor 105. The input conveyor 105 moves in a clockwise direction and so the harvested leaves travel towards a drop area 130 at the end of the input conveyor 105.

[0018] Located above the input conveyor 105 is a second conveyor 110 which travels in an anticlockwise direction. As can be seen from Figure 1, a fan 120 is located above the second conveyor 110. The fan 120 provides a suction area on a first part of the second conveyor 110. The second conveyor 110 is constructed from a mesh. In embodiments, the mesh is made from food grade plastic with circular shaped holes, each hole being 2 mm in diameter. Advantageously, by making the mesh from plastic, it is less likely the leafed product will be damaged during processing. However, the invention is not limited and the mesh may be made from any type of material.

[0019] It should be also noted that the mesh may have any size or shape or holes in the mesh. Advantageously, in embodiments the size and/or shape of the holes in the mesh will be selected to allow debris to pass through the mesh whilst keeping the leafed produce against the mesh. In other words, the mesh is selected to be large enough to allow soil, small insects and other debris to pass through the mesh and away from the leaf, whilst

being small enough to ensure that the harvested leafed product to stay sucked against the second conveyor 110. The size and/or shape of the mesh is therefore selected in dependence upon the size of the leafed product. This means that the suction is used to partially clean the harvested leaf of debris before it is eventually washed and packed.

[0020] Another advantage with selecting the size and/or shape of the mesh in this manner is that as dirt and small insects are removed from the surface of the mesh by being sucked through the mesh, the conveyor has less debris trapped thereon. This means that less suction power is lost during operation allowing harvested leaves to be more easily held against the mesh. Given this, the conveyor will need to be cleaned less often during harvesting.

[0021] The size and shape of mesh will, in embodiments, be selected in dependence upon the leafed product. For example, larger sized leaves such as spinach may have a larger mesh size. However, smaller sized leaved such as rocket would have a smaller mesh size. For example, for larger leafed products like spinach, a mesh having a diameter of 20mm may be suitable. For a smaller leafed product like rocket, a mesh having a diameter of 2-5mm may be suitable. The mesh on the conveyor may be changed in dependence upon which leafed product is being harvested.

[0022] Alternatively, a mesh that is suitable for most leaves may be selected, such as a mesh having a diameter of 10mm. The advantage of this is that the conveyor would not require changing when different leafed produce are being harvested.

[0023] The mesh allows air to pass through the second conveyor 110. In other words, as the second conveyor 110 has holes located within the second conveyor 110 the suction from the fan 120 will be applied to the harvested produce located on the input conveyor 105. In order to facilitate the flow of air, holes may also be provided in the input conveyor 105 to allow air to flow through the input conveyor.

[0024] As the harvested leaves and any foreign objects travel along the input conveyor 105, they will eventually be subjected to the suction created by fan 120. Specifically, the harvested leaves and any foreign objects will be subjected to the suction created by fan 120 as they pass underneath the first part of the second conveyor 110. The airflow through the fan 120 is controlled to suck the harvested leaves from the input conveyor 105 onto the second conveyor 110. As the second conveyor 110 travels along the suction area, the harvested leaves will be sucked against the second conveyor 110.

[0025] It should be noted here that as the leaves are held against the second conveyor 110 whilst the second conveyor 110 moves, the harvested leaves are stationary relative to the second conveyor 110 whilst the second conveyor 110 moves along the suction area 125. This means the harvested leaves are less likely to be damaged whilst moving along the suction area 125.

[0026] The suction produced by fan 120 is controlled such that the harvested leaves are sucked against the second conveyor 110 whilst leaving foreign objects which are more dense than each leaf within the harvested leaves on the input conveyor 105. As an example, the air speed created by fan 120 may be between 11 to 35 ms^{-1}. Of course, the air speed may be less than or greater than this and will depend upon the density of the harvested leaves and the density of the foreign objects to be removed from the leaves.

[0027] At the end of the input conveyor 105, the drop area 130 is produced by a gap between the input conveyor 105 and an output conveyor 135. Under the drop area 130 is located a collection box 115. As can be seen from Figure 1, the suction area 125 extends across the drop area 130. In other words, the suction area 125 bridges the drop area 130. Therefore, any harvested leaves which are sucked onto the second conveyor 110 pass over the drop zone 130. Additionally, any foreign objects that are not sucked onto the second conveyor 110 fall into the gap between the input conveyor 105 and the output conveyor 135. The foreign objects are collected in collection box 115. In embodiments, the collection box 115 may have a funnelled entrance which stops any mice or frogs from climbing back out of the collection box 115. The collection box 115 will be emptied periodically so that any collected wildlife can be logged and released unharmed.

[0028] The suction area 125 extends along the second conveyor belt 110 and overlaps with the output conveyor 135. As the harvested leaves held against the second conveyor 110 go beyond the suction area 125, they fall from the second conveyor 110 and land onto the output conveyor 135. This is because the harvested leaves pass through the suction area 125 and eventually have no suction applied to them. The output conveyor 135 then moves the harvested leaves to the washing and packing process. As the washing and packing process is not relevant to the removal of foreign objects, this process will not be described in any detail.

[0029] Advantageously, the second conveyor belt 110 travels more quickly than the input conveyor 105. This is because, in reality, bunches of harvested leaves may be placed on the input conveyor belt 105. This means that several harvested leaves may be located one on top of the other on the input conveyor belt 105. The top leaf in the bunch of harvested leaves will be sucked onto the second conveyor belt 110, leaving the remaining harvested leaves from the bunch on the input conveyor belt 105. If the input conveyor 105 travelled at the same speed as the second conveyor belt 110, the remaining harvested leaves in that bunch will not be collected as the top leaf from the bunch is blocking the suction. Therefore, the remaining leaves in the bunch may end up falling into the collection box 115.

[0030] Therefore, by ensuring that the second conveyor belt 110 moves more quickly than the input conveyor belt 105, where a bunch of harvested leaves is placed

on the input conveyor 105, the top leaf from the bunch will be sucked onto the second conveyor 110 and will move away from the bunch travelling on the input conveyor 105. Accordingly, an area on the second conveyor 110 will be provided above the bunch of harvested leaves allowing the suction from the fan 120 to be applied to the next leaf in the bunch. An example of the range of belt speeds for the input conveyor 105 is 0.1 to $1ms^{-1}$. This speed varies depending on the rate at which harvested leaves are placed on the input conveyor 105. Additionally, as noted above, the second conveyor 110 will move at a speed quicker than the input conveyor 105. For example, the second conveyor 110 will move at 0.2 to $2ms^{-1}$ (or twice as quickly as the input conveyor 105). Alternatively, the second conveyor 110 may move at any other speed that is quicker than the input conveyor 105.

[0031] Although the foregoing describes leafed products in terms of lettuce, spinach or rocket, the skilled person would appreciate that other leafed products such watercress or herbs like coriander or dill may also be harvested. In this case, the weight, surface area and/or density of leafed products like coriander or dill will be different to those of spinach or rocket. Accordingly, it may be necessary to increase or decrease the suction provided by the fan 120. This may be achieved by increasing or decreasing the speed of the fan 120. Alternatively or additionally, the amount of suction applied to the harvested leaves may be adjusted by altering the size or shape of the mesh from which the second conveyor belt 110 is made. In other words, the larger the diameter of the mesh, the more suction will be applied to the harvested leaves. Clearly, the amount of suction can be selected to additionally or alternatively remove foreign objects having varying weights and/or densities.

[0032] Moreover, it should be appreciated that the second conveyor 110 need not be located directly above the input conveyor 105. Indeed, the second conveyor 110 may be located to one side of the input conveyor 105, for example perpendicular to the input conveyor 105. Also, there may be more than one second conveyor, for example located on either side of the input conveyor 105. Indeed, the only requirement for the position of the second conveyor(s) 110 relative to the input conveyor 105 is that the second conveyor(s) traverses the gap between the input conveyor 105 and the output feed (which may be an output conveyor or a hopper) to allow the foreign objects to fall through the gap.

[0033] A second embodiment is described in Figure 2. In this embodiment, there are many features that are common to the first embodiment. These common features have the same reference numerals. For brevity, these features and possible adaptations will not be described. The difference between the first embodiment and the second embodiment is the use of ducting 205 between the fan 120 and a suction zone 210. As the skilled person would appreciate, ducting 205 is a pipeline between the input of the fan 120 and a suction head 215.

[0034] The suction head 215 may be made from moulded plastic. Typically, the edge of the suction head may be provided with a rubber seal which ensures that the suction zone 210 is located directly underneath the suction head 215. The rubber seal provides a better seal between the head 215 and the second conveyor.

[0035] The provision of ducting 205 enables the fan 120 to be located remotely from the device 200. This has two effects. Firstly, this ensures that the device 200 can be made smaller than in the first embodiment as the size of the device 200 is not determined by the size of the fan. Secondly, the fan 120 can be located in a convenient position rather than being located directly next to the device 200.

[0036] Additionally, the size of the fan 120 in the first embodiment determines the size of the suction area 125. Therefore, in the first embodiment, the size of the suction area is limited by the geometry of the fan 125. However, in the second embodiment as the suction zone 210 is determined by the size of the suction head 215 there is more flexibility in the selection of the size of suction zone 210. In particular, the overall cost of the device 200 may be reduced because the suction head 215 is made from moulded plastic which is cheaper to produce than providing a fan 120 having the correct dimensions to create an appropriately sized suction area.

[0037] Although not shown in Figure 2, a vent may be provided in the ducting 205 whose size may be varied. The size of vent enables the amount of suction to be varied. In other words, for maximum suction, the vent will be closed and for minimum suction, the vent will be fully open. The size of the vent therefore provides an additional mechanism by which the suction applied to the harvested leaves can be controlled. Indeed, one further advantage with having a vent in the ducting 205 is that when the suction zone 210 is full of harvested leaves, a small opening within the vent would stop the fan 120 from overheating or stalling.

[0038] Although the foregoing second embodiment shows a single suction head 215, the invention is not so limited and a plurality of suction heads of varying sizes may be used instead. Indeed, a suction head 215 need not be provided and simply the end of the ducting 205 may be used to create one or more suction zones.

[0039] Although the foregoing embodiments show an output conveyor, the invention is not so limited. For example, the second conveyor 110 may drop the harvested leaves into a hopper directly. In this case, there is no requirement for an output conveyor 135.

[0040] Although the foregoing embodiments show the second conveyor being located directly above the input conveyor 105 the invention is not so limited. For example, the second conveyor may be located perpendicular to the input conveyor. In this case, the harvested leaves would be sucked across the input conveyor onto the second conveyor.

[0041] Although the foregoing embodiments show a fan 120, the invention is not so limited. For example, an air pump may be used instead.

[0042] Referring to Figure 3, a device of either the first embodiment or the second embodiment is shown attached to a harvester 300 which harvests leaves 335 located on a field. The harvester 300 has a driving part 305 which may be a tractor type vehicle or it may be self propelled. The harvester 300 has a leaf harvesting mechanism as known to the skilled person in the art attached to the driving part 305. Additionally, the harvester is equipped with the device of either the first embodiment or the second embodiment of the invention. This is mounted on a trailer 340. In the example of Figure 3, the device of the second embodiment is shown with the fan 120 being attached to the cab of the driving part 305.

[0043] The leaves that are harvested using the known leaf harvesting mechanism are routed from a feed point 310 to the input conveyor 105. The fed leaves may form groups of leaves 315 on the input conveyor 105. The leaves are sucked onto the second conveyor 110 which carries the leaves 320 along the suction zone provided by the suction head 215. The leaves 325 fall from the second conveyor 110 into the hopper 330. The harvested leaves having had foreign objects removed are then placed in a hopper 330 within the harvester that is periodically emptied and taken for further processing within the washing and packing procedure.

[0044] Another useful embodiment of the present invention will now be described. In Figure 4, a prior art harvester system 400 is shown. This harvester system 400 has harvester vehicle 405 and a collection bin 410 attached to the back of the harvester vehicle 405. The collection bin 410 collects the harvested leafed product and is periodically emptied. Mounted on the top of the harvester vehicle 405 is a conveyor belt 420. The conveyor belt 420 is typically made from a mesh. The harvested leaves 425 travel along the conveyor belt 420 towards the collection bin 410. As indicated by the arrows 435, the conveyor belt 420 is agitated as it moves towards the collection bin 410. The agitation is in both the horizontal and vertical direction relative to the harvester vehicle 405 as indicated by the arrows 435. The reason for agitating the conveyor belt 420 is to loosen dirt and insects from the harvested leaves. This results in dirt and small insects falling through the conveyor belt 420. Additionally, this agitation places the leaves in a single layer which allows the pick-up of the leaves to be more easily performed. The harvested leaves having been through the agitation process are then fed into the collection bin 410.

[0045] In Figure 5, a harvester system 500 according to an embodiment of the present invention is shown. In this system, a harvester vehicle 505 has a collection bin 510 attached thereto. The first conveyor 525 has harvested leafed produce 530A located thereon. The fan 515 sucks leafed produce 530B onto the second conveyor 520. The harvested leafed produce 530B gets fed into the collection bin 510. The arrangement of the first and second conveyor and the fan is similar to that of Figure 1.

[0046] As the system 500 sucks small insects and dirt from the leafed produce (see the discussion in relation to Figure 1), there is no need to agitate the first and second conveyor belts. In other words, the arrangement of Figure 1 or Figure 2 described hereinbefore may replace the agitator conveyor arrangement of the prior art on the harvester vehicle.

[0047] Although the foregoing discloses to embodiments, the skilled person will appreciate that other features may be provided and that these features and/or adaptations are well within the scope of the common general knowledge of the skilled person. Indeed, the scope of the invention should only be limited by the claimed appended hereto.

Claims

1. A device for removing a foreign object from harvested leaves, the foreign object being more dense than each leaf in the harvested leaves, the device comprising: an input feed conveyor operable to receive the harvested leaves; a second conveyor having a plurality of holes which allow air and debris from the harvested leaves to flow therethrough and being separated from the input feed conveyor by a gap; a suction device operable to suck air through a first area of the second conveyor, the suction being sufficient to draw the harvested leaves from the input feed conveyor onto the second conveyor whilst leaving the foreign object on the input feed conveyor; and an output separated from the input conveyor by a second gap bridged by the first area of the second conveyor, where the output is located below a second area of the second conveyor, wherein the suction device is operable to lose sufficient suction at the second part of the second conveyor so that the harvested leaves fall from the second conveyor to the output

2. A device according to claim 1, wherein the output is either an output conveyor or a hopper.

3. A device according to either claim 1 or 2, wherein the second conveyor is positioned above the input feed conveyor.

4. A device according to any preceding claim, wherein the suction device is a fan located directly above the first part of the second conveyor.

5. A device according to any one of claims 1, 2 or 3, wherein the suction device is a fan having an input connected to ducting at one open end, whereby the other open end of the ducting extends along the first part of the second conveyor.

6. A device according to any one of the preceding claims, wherein the suction device has variable suc-

tion power provided by a variable speed fan.

7. A device according to claim 5 or 6, wherein the suction device has variable suction power provided by a variable sized opening along the length of the ducting.

8. A device according to any one of claims 5, 6 or 7, wherein the other open end of the ducting is connected to a suction head having a rubber seal provided between the suction head and the second conveyor.

9. A device according to any preceding claim, wherein the second conveyor is made from plastic mesh.

10. A device according to any of claims 1 to 8, wherein the second conveyor is made from mesh comprising a plurality of holes, the size and/or shape of the holes being determined in dependence upon the dimensions of the harvested leaves.

11. A device according to claim 10, wherein i) the harvested leaves are spinach and the diameter of the mesh is 20 mm or ii) the harvested leaves are rocket and the diameter of the mesh is between 2 and 5 mm.

12. A device according to claim 10, wherein the mesh has a diameter of 10 mm.

13. A harvester comprising a picking device to harvest leaves and a device according to any preceding claims.

14. A method of removing a foreign object from harvested leaves, the foreign object being more dense than each leaf in the harvested leaves, the method comprising: receiving the harvested leaves on an input feed conveyor; sucking air through a first area of a second conveyor, the second conveyor having a plurality of holes which allow air and debris from the leaves to flow therethrough and being separated from the input feed conveyor by a gap, wherein the suction is sufficient to draw the harvested leaves from the input feed conveyor onto the second conveyor whilst leaving the foreign object on the input feed conveyor; and losing sufficient suction at a second part of the second conveyor so that the harvested leaves fall from the second conveyor to an output, wherein the output is separated from the input conveyor by a second gap which is bridged by the first area of the second conveyor.

15. A method according to claim 11, wherein harvested leaves lose sufficient suction over either an output conveyor or a hopper.

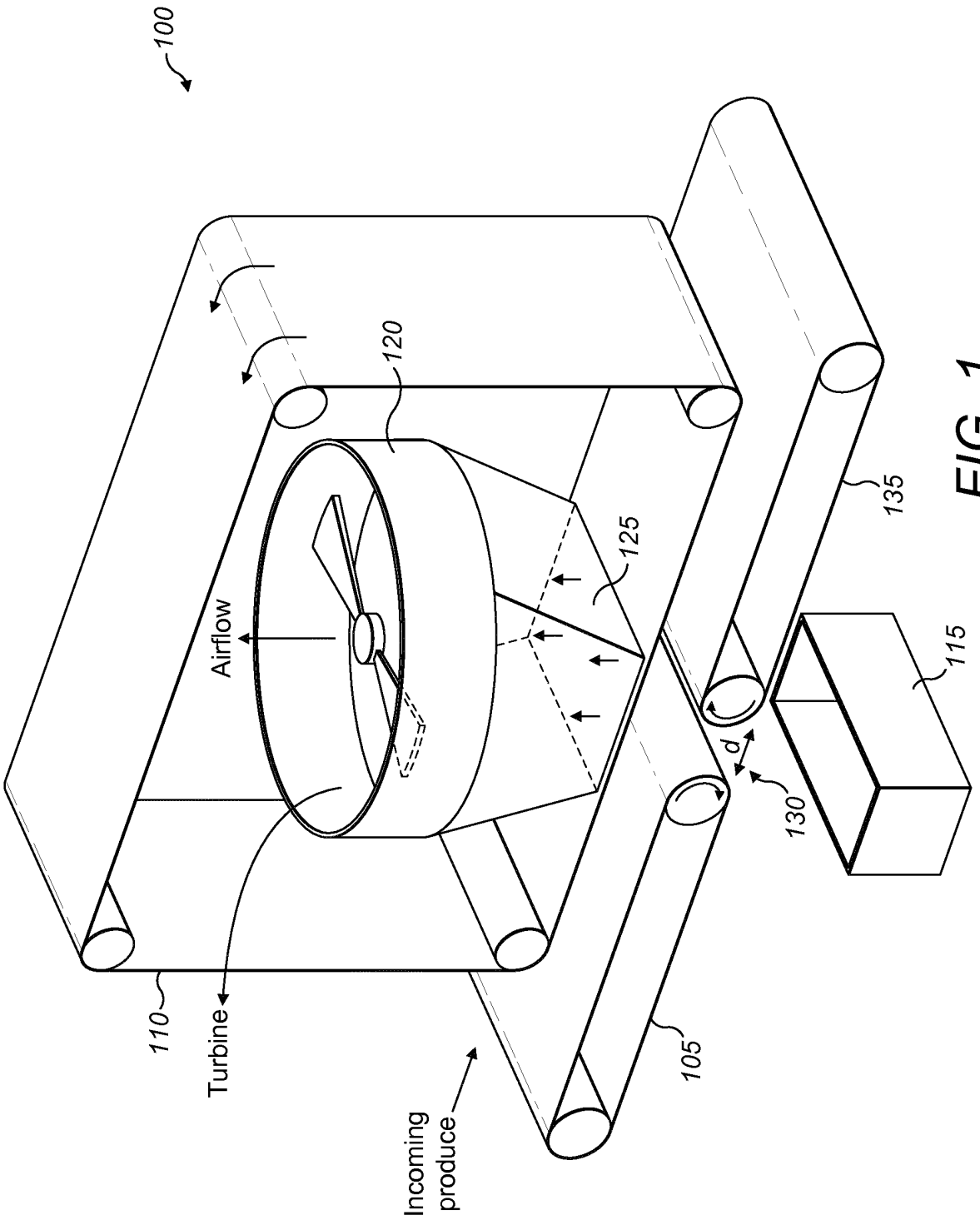
100
120
125
135
115
Airflow
d
130
110
Turbine
105
Incoming
produce

FIG. 1

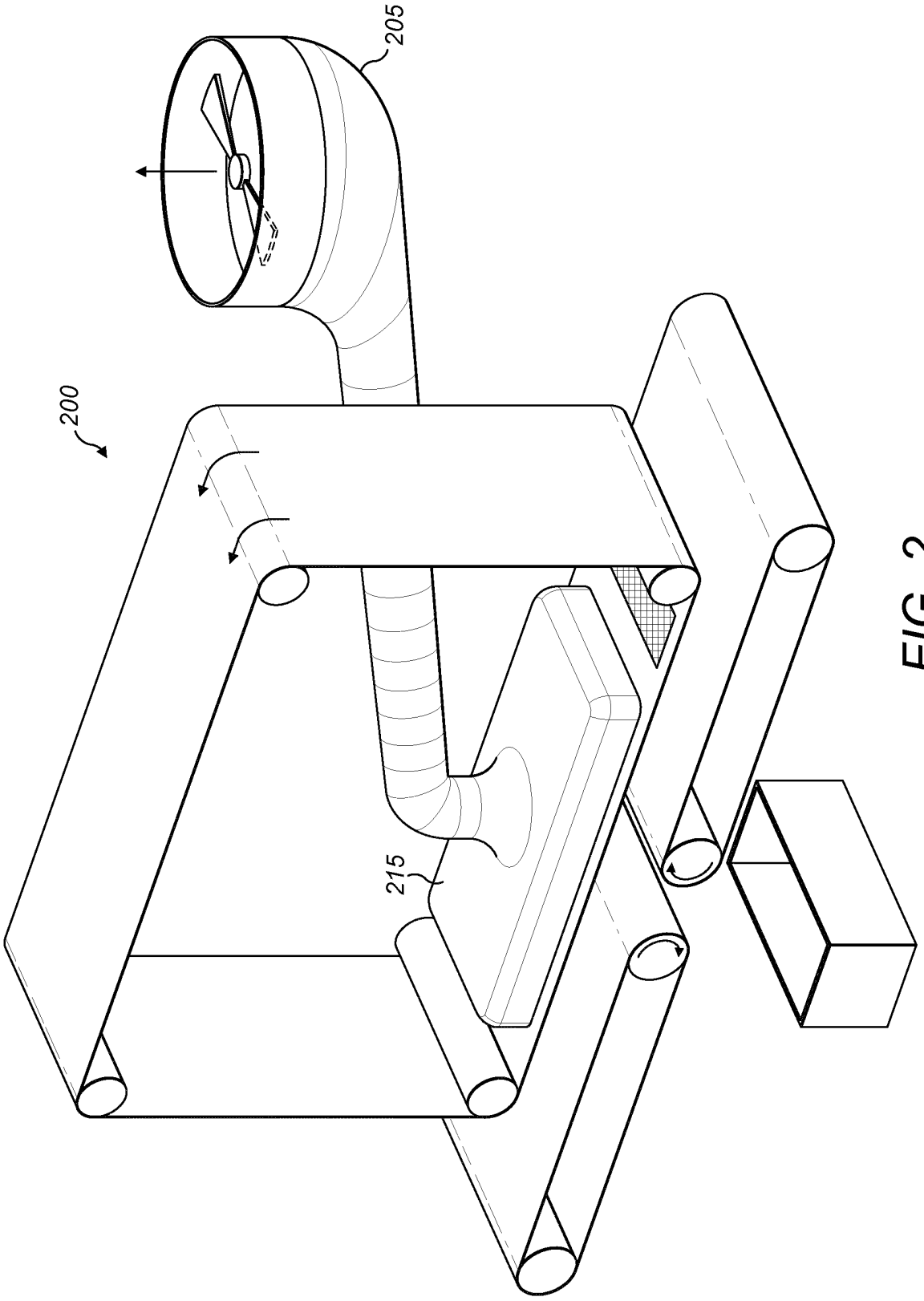

FIG. 2

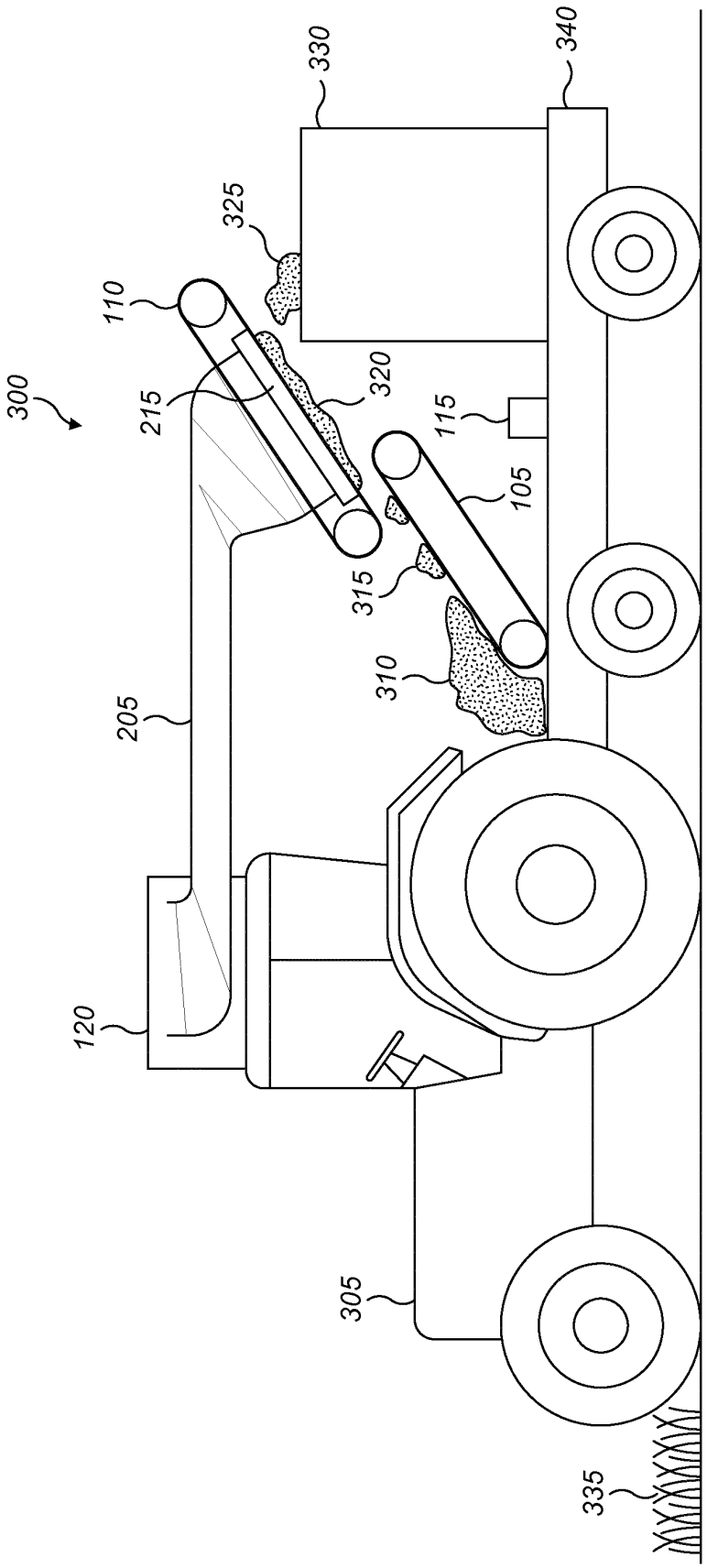

FIG. 3

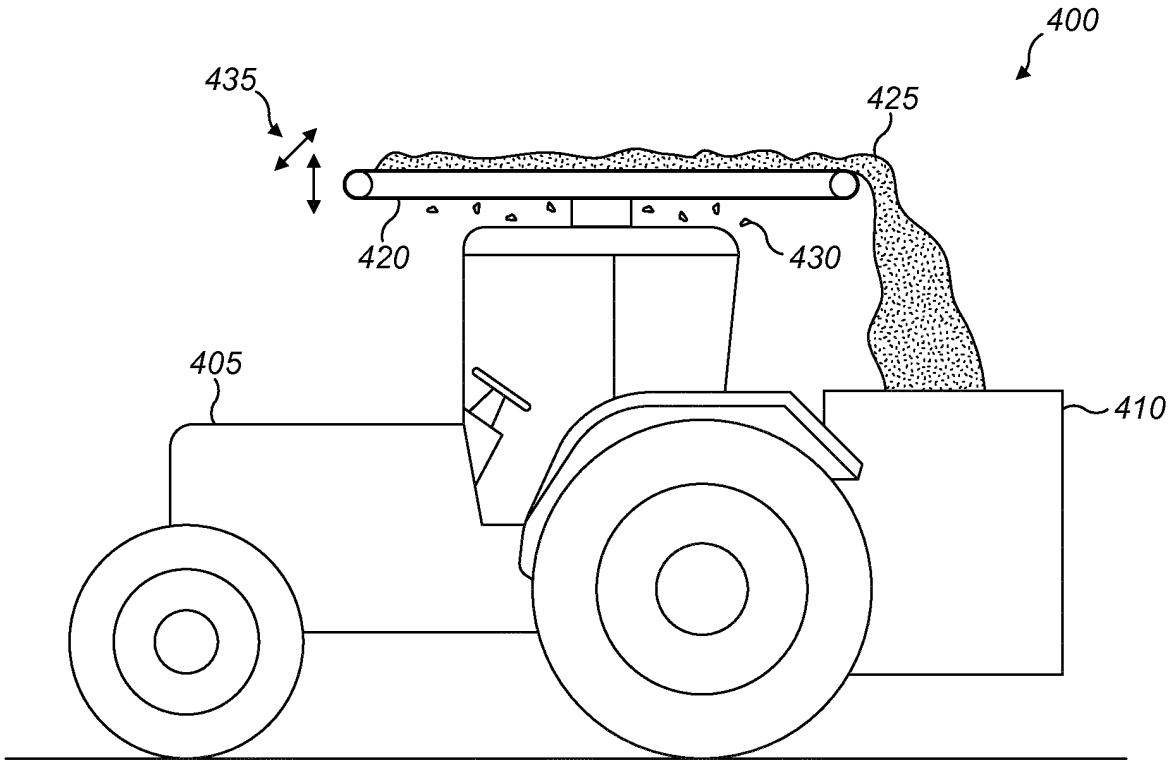

FIG. 4
(Prior art)

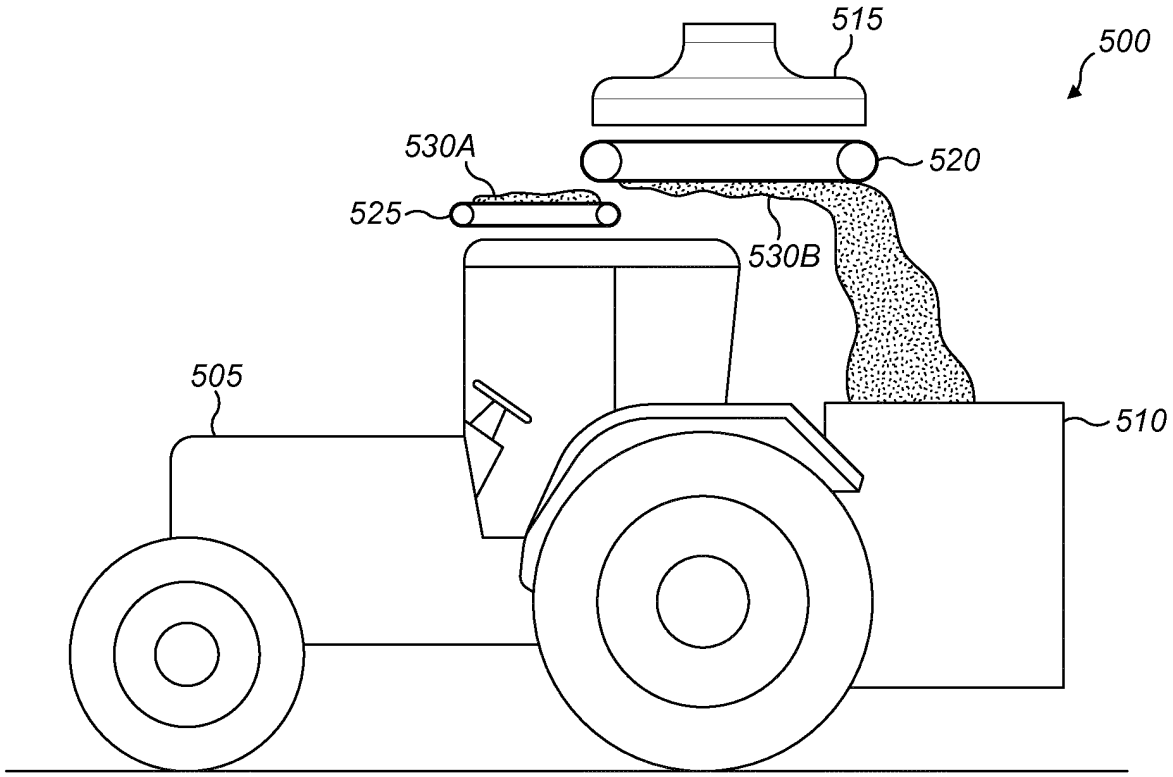

FIG. 5