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(54) Method and apparatus for aligning crop articles for grading

(57) Apparatus and a method for inspecting and sorting crop articles (14) such as fruit and vegetables comprising at least one drivable roller conveyor (16) onto which crop articles are presented, an inspection device (28) under which the articles (14) conveyed which inspects and scans the articles (14) as they pass, a control system for analysing and processing the data obtained and adapted, article removal devices which may be actuated to displace/remove articles from the roller conveyor in response to the data, and having at least one discharge location wherein said apparatus is also provided with crop article location means (26) which act on said crop articles (14) to facilitate the positioning of same prior to inspection.

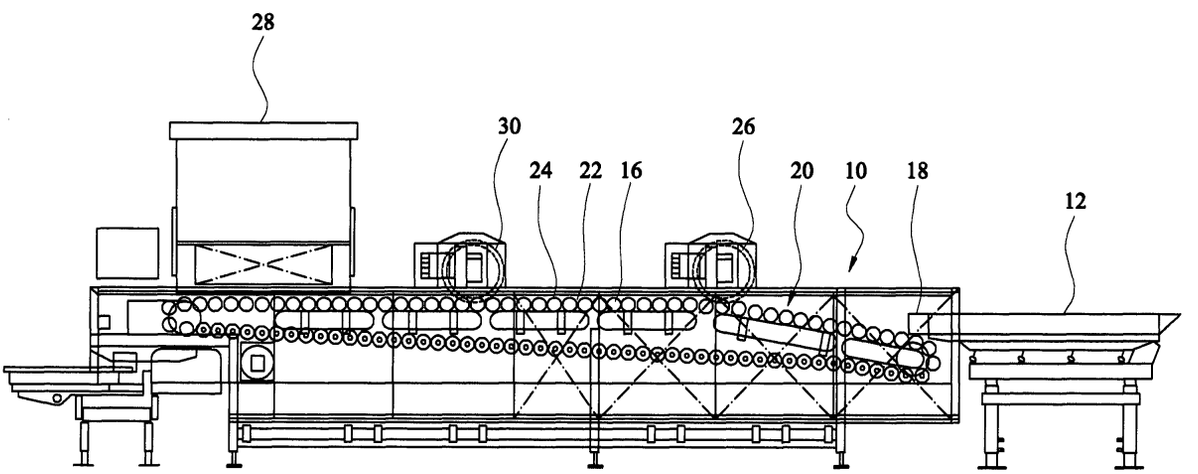

FIG. 1

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Description

[0001] This invention relates to a method of and apparatus for automatically sorting articles such as harvested fruit and vegetable crops in accordance with their size and the presence and seriousness of defects. More particularly, the invention relates to presenting articles such as harvested fruit and vegetables prior to sorting.

[0002] Apparatus for inspecting and sorting crop items generally comprises a roller conveyor onto which articles are presented from a discharge chute. The conveyor carries the articles under a viewing device or inspection zone at which a camera-type scanning unit is mounted overhead of the conveyor in such a way that the camera can scan the articles as they pass underneath. The roller elements of the conveyor are driven to rotate during the scanning process in order that the articles thereon also rotate to afford as full a view as possible of the articles.

[0003] Apparatus such as a video grabber converts the visual image data provided by the camera. This information is passed to a central processing unit which analyses and evaluates the images of the individual article created by the camera as to size, grade and orientation as well as position in the direction of travel and the space occupied on the conveyor as the article sits in the valleys formed between successive roller elements. Any defects present are characterised into groups in accordance with pre-determined characteristics and converted into a numerical value, such as a percentage. An operator establishes, by means of a set-up screen, the required characteristics or numerical value of the particular grade to be selected for. The operator controlled program then establishes a discharge position where selected articles will be removed from the conveyor according to the required classification, that is by size, grade or direction of orientation. The central processing unit would determine the point at which the selected article is to be removed and how many actuators to activate to cause the article removal devices located under the product in order to flip the article onto a take out conveyor or flume.

[0004] However, this system of monitoring and grading relies on the crop article being presented to the scanning unit in the optimum orientation in order that the article can be rotated as it is scanned to provide as full a view as possible on which to make a grading determination.

[0005] Difficulties have been encountered when sorting and grading some crop articles, particularly elongate items such as carrots, parsnips and maize. It has been found that these items do not reliably fall into the valleys formed between the rollers of the conveyor and align longitudinally as the crop travels towards the scanning unit but may lie transversely to the rollers, above the valleys. In this orientation the rollers cannot act on the crop item to rotate it as it passes under the scanning unit, nor is the crop item presented in an optimum orientation for scanning. As such, the crop cannot be graded accurately.

[0006] In addition, excessive volume of crop articles on the roller conveyor has been found to cause "doubles" (two articles in one valley or articles overlapping) which also has a detrimental effect on the accuracy of the scanning step.

[0007] An object of the present invention is to provide improvements in relation to one or more matters discussed herein or generally.

[0008] According to the invention there is provided apparatus for inspecting and sorting crop articles such as fruit and vegetables comprising at least one drivable roller conveyor onto which crop articles are presented, an inspection device under which the articles conveyed which inspects and scans the articles as they pass, a control system for analysing and processing the data obtained and adapted, article removal devices which may be actuated to displace/remove articles from the roller conveyor in response to the data, and having at least one discharge location wherein said apparatus is also provided with crop article location means which act on said crop articles to facilitate the positioning of same prior to inspection.

[0009] In an embodiment of the invention apparatus for aligning crop articles prior to scanning and grading comprises an in-feed delivery unit which feeds the articles to be graded and sorted onto a rotating roller conveyor from a discharge chute. The discharge chute may oscillate to assist alignment and movement of the articles discharged onto the conveyor. The conveyor carries the objects under a viewing device or inspection zone at which a camera-type scanning unit is mounted overhead of the conveyor in such a way that the camera can scan the articles as they pass underneath. The roller elements of the conveyor are driven to rotate during the scanning process in order that the articles thereon also rotate to afford as full a view as possible of the articles.

[0010] Apparatus such as a video grabber converts the visual image data provided by the camera. This information is passed to a central processing unit which analyses and evaluates the images of the individual article created by the camera as to size (length/diameter/volume), grade (rot, cracks, damage etc) and orientation as well as position in the direction of travel and the space occupied on the conveyor as the article sits in the valleys formed between successive roller elements. Any defects present are characterised into groups in accordance with pre-determined characteristics and converted into a numerical value, such as a percentage. An operator establishes, by means of a set-up screen, the required characteristics or numerical value of the particular grade to be selected for. The operated controlled program then establishes a discharge position where selected articles will be removed from the conveyor according to the required classification, that is by size, grade or direction of orientation. The central processing unit would determine the point at which the selected ar-

ticle is to be removed.

[0011] The roller conveyor acts as a pre-feeder for a grading conveyor. The articles are delivered in a continuous flow onto the roller conveyor which advances underneath the delivered crop at an incline sufficient to lift, level and separate the crop articles into transverse valleys between the rollers forming the conveyor and aid alignment prior to scanning. At this point, the majority of articles which are lying transversely or doubling are affected by the incline and fall back whereupon a further opportunity is presented for the article to take up the correct alignment, namely in the valleys between the roller elements of the conveyor.

[0012] Positioned over the roller conveyor at the top of the inclined section is a crop article locating means. This may comprise a rotatable roller with projections, a rotating brush or any other suitable combination. The brush rotates in the direction of travel of the conveyor but at a faster speed than the speed of travel of the conveyor. If the crop article is correctly orientated in a valley between the roller elements it will pass underneath the brush and travel onward towards the grading conveyor and scanner. However, if the crop article is doubling or lying transversely to the valley it will be somewhat "proud" of the surface of the conveyor. Accordingly it will be caught by the rotating brush and swept or flicked forward along the conveyer towards the grading conveyor. This movement of the crop articles by the brush facilitates a further opportunity for the crop article to fall into a valley between the roller elements of the grading conveyor and be presented for scanning in the correct orientation.

[0013] In an alternative embodiment of the invention, the brush rotates in the opposite direction of travel of the conveyor but at a faster speed than the speed of travel of the conveyor. If the crop article is correctly orientated in a valley between the roller elements it will pass underneath the brush and travel onward towards the grading conveyor and scanner. However, if the crop article is doubling or lying transversely to the valley it will be somewhat "proud" of the surface of the conveyor. Accordingly it will be caught by the rotating brush and flicked backwards towards the crop delivery area at the bottom of the incline where a further opportunity will be presented for the crop item to be lifted by the roller conveyor in the correct orientation for presentation to the scanner.

[0014] As the crop articles travel towards the grading conveyor and scanner, the roller elements continue to rotate and this can have the effect of dislodging crop items which are lying in the valleys causing them to take up an incorrect orientation as regards the impending scanning. In addition, some small crop items may pass under the rotating brush in the incorrect position. Accordingly, a second rotating brush is provided at a spaced location from the first. The second brush rotates in the direction of travel of the roller conveyor but at a faster speed and is located above the roller conveyor to act on such items in a similar manner to the first brush. However, as the crop articles have now moved further along the conveyor, they cannot be flicked" back sufficiently at this location such that they drop away from the conveyor, thus allow sufficient time for them to be picked up again by the inclined roller and represented as happens after the crop article is acted upon by the first brush first brush.

[0015] It is important to ensure that crop articles which do not pass under the second brush are moved sufficiently far back along the conveyor to allow time for reorientation and to prevent a build up of incorrectly orientated crop items directly in front of the brush which would prevent the passage under the brush of correctly orientated articles. This is achieved by causing a group of rollers, for example but not limited to five or six, which make up the roller conveyor to be rotatable at a different speed and in a different direction to the remaining rollers - of the conveyor. This group of rollers can be caused to rotate at a much faster speed and in the reverse direction to the direction of travel of the conveyor as a whole, thus creating a type of contra flow. This group of rollers are positioned at a spaced location from the second brush such that any crop article which is caught by the second brush and flicked away will land on the contra rotating rollers and be carried back along the conveyor. As the surface area speed of the contra rotating rollers is greater than the linear speed of the conveyor this assists to ensure the incorrectly orientated crop articles are caused to move backwards far enough to allow time for them to align correctly. The rollers are then caused to rotate in the same direction and at the same speed as the remainder of the rollers making up the conveyor in order to allow the correctly aligned crop articles to travel under the second brush.

[0016] After the crop articles pass under the second brush, they then pass from the roller conveyor on to the grading conveyor prior to being scanned.

[0017] In some applications, the grading conveyor may be located beneath the roller conveyor such that the crop articles can drop from one to the other. However, there is a risk that in dropping from one conveyor to another the crop article will because misaligned so as to lie in a transverse position relative to the valleys in the grading conveyor or else to double up. In order to prevent this, a third rotating brush may be located at the end of the roller conveyor and above the grading conveyor. As crop articles reach the end of the roller conveyor and fall away from the conveyor they are caught by the bristles of the third brush which acts to hold the crop article in the valley as long as possible until the roller conveyor returns and lowers it into a valley in the grading conveyor thus maintaining the correct alignment whereby the crop article can be presented to the scanner correctly.

[0018] All of the rotating brushes, rollers with projections or the like may be height adjustable with respect to the conveyors. In addition the speed of rotation of the

brushes may also be variable.

[0019] According to the invention there is also provided a method of aligning crop articles prior to scanning comprising the steps of providing at least one drivable roller conveyor onto which crop articles are presented, an inspection device under which the articles conveyed which inspects and scans the articles as they pass, a control system for analysing and processing the data obtained and adapted, article removal devices which may be actuated to displace/remove articles from the roller conveyor in response to the data, and at least one discharge location and the further step of providing crop article location means which act on said crop articles to facilitate the positioning of same prior to inspection.

[0020] By providing a method and apparatus for aligning crop articles prior to scanning, this ensures that as many crop articles as possible are presented in the optimum orientation for scanning and grading. This will ensure that crop articles are sorted and graded more efficiently thereby reducing the number of crop articles being graded incorrectly which will adversely affect profitability

[0021] An embodiment of the invention will now be described is also described by way of example with reference to the accompanying illustrative drawings in which:

Figure 1 shows a side elevation of the inspection and sorting apparatus according to the invention;

Figure 2 shows a perspective view of a region of the roller conveyor and a crop article location means; and

Figure 3 shows a further perspective view of the roller conveyor and two crop article location means

[0022] As shown in the drawings, apparatus for aligning crop articles prior to scanning and grading 10 comprises an in-feed delivery unit 12 which feeds the articles 14 to be graded and sorted onto a rotating roller conveyor 16 from a discharge chute 18. The discharge chute 18 may oscillate to assist alignment and movement of the articles discharged onto the conveyor 16.

[0023] The roller conveyor 16 acts as a pre-feeder for a grading conveyor. The articles 14 are delivered in a continuous flow onto the roller conveyor 16, a region 20 of which advances underneath the delivered crop at an incline sufficient to lift, level and separate the crop articles 14 and aid alignment in the valleys 22 between the rollers 24.

[0024] Positioned over the roller conveyor 16 at the top of the inclined section is a crop article locating means 26. This may comprise a rotating brush. The locating means 26 rotates in the direction of travel of the conveyor 16 but at a faster speed than the speed of travel of the conveyor 16. If the crop article 14 is correctly orientated in a valley 22 between the roller elements 24 it will pass underneath the locating means 26 and travel onward towards the grading conveyor and scanner 28. However, if the crop article 14 is doubling or lying transversely to the valley 22 it will be somewhat "proud" of the surface of the conveyor 16. Accordingly it will be caught by the rotating location means 26 and swept or flicked forward along the conveyer 16 towards the grading conveyor. This movement of the crop articles 14 by the location means 26 facilitates a further opportunity for the crop article 14 to fall into a valley 22 between the roller elements 24 of the conveyor 16 and be presented for scanning in the correct orientation.

[0025] In an alternative embodiment of the invention, the brush 26 rotates in the direction of travel of the conveyor 16 but at a faster speed than the speed of travel of the conveyor 16. If the crop article 14 is correctly orientated in a valley 22 between the roller elements 24 it will pass underneath the brush 26 and travel onward towards the grading conveyor and scanner 28. However, if the crop article 14 is doubling or lying transversely to the valley 22 it will be somewhat "proud" of the surface of the conveyor 16. Accordingly it will be caught by the rotating brush 26 and flicked backwards towards the crop delivery area at the bottom of the inclined region 20 of the conveyor 16 where a further opportunity will be presented for the crop item 14 to be lifted by the roller conveyor 16 in the correct orientation for presentation to the scanner 28.

[0026] As the crop articles 14 travel towards the grading conveyor and scanner 28, the roller elements 24 continue to rotate and this can have the effect of dislodging crop items 14 which are lying in the valleys 22 causing them to take up an incorrect orientation as regards the impending scanning. In addition, some small crop items 14 may pass under the rotating brush 26 in the incorrect position. Accordingly, as shown in Figure 3, a second rotating brush 30 is provided at a spaced location from the first 26. The second brush 30 rotates in the direction of travel of the roller conveyor 16 but at a faster speed and is located above the roller conveyor 16 to act on such items to "flick" these back along the conveyor 16 to allow time for them to fall into the valleys 22 and therefore be in the correct orientation for scanning.

[0027] However, as the crop articles 14 have now moved further along the conveyor 16, they cannot be "flicked" back sufficiently at this location such that they drop away from the conveyor 16, thus allow sufficient time for them to be picked up again by the inclined region 20 of the roller conveyor 16 and represented as happens after the crop article 14 is acted upon by the first brush in the second embodiment of the invention and to assist with re-orientation in both embodiments, it is important to ensure that crop articles 14 which do not pass under the second brush 30 are moved sufficiently far back along the conveyor 14 to allow time for reorientation and to prevent a build up of incorrectly orientated crop items 14 directly in front of the brush 30 which would prevent the passage under the brush 30 of correctly orientated

articles. This is achieved by causing a group of rollers 24 to be rotatable at a different speed and in a different direction to the remaining rollers 24 of the conveyor 16. This group of rollers can be caused to rotate at a much faster speed and in the reverse direction to the direction of travel of the conveyor 16 as a whole, thus creating a type of contra flow. This group of rollers are positioned at a spaced location from the second brush 30 such that any crop article 14 which is caught by the second brush 30 and flicked away will land on the contra rotating rollers and be carried back along the conveyor 16. As the surface area speed of the contra rotating rollers is greater than the linear speed of the conveyor this assists to ensure the incorrectly orientated crop articles 14 are caused to move backwards far enough to allow time for them to align correctly. The rollers are then caused to rotate in the same direction and at the same speed as the remainder of the rollers making up the conveyor 16 in order to allow the correctly aligned crop articles 14 to travel under the second brush 30.

[0028] After the crop articles 14 pass under the second brush 30, they then pass from the roller conveyor 16 on to the grading conveyor prior to being scanned.

Claims

1. Apparatus for inspecting and sorting crop articles such as fruit and vegetables comprising:

   a) at least one drivable roller conveyor onto which crop articles are presented;
   b) an inspection device under which the articles conveyed which inspects and scans the articles as they pass;
   c) a control system for analysing and processing the data obtained and adapted;
   d) article removal devices which may be actuated to displace/remove articles from the roller conveyor in response to the data; and
   e) at least one discharge location

   characterised in that crop article location means are provided which act on said crop articles to facilitate the positioning of same prior to inspection.

2. Apparatus according to claim 1 **characterised in that** said crop article location means is located above the roller conveyor.

3. Apparatus according to claim 2 **characterised in that** said crop article location means is provided with a plurality of projections which contact the crop articles.

4. Apparatus according to claim 3 **characterised in that** said projections are in the form of bristles.

5. Apparatus according to claim 4 **characterised in that** said crop article location means comprises a rotatable brush.

6. Apparatus according to claim 5 **characterised in that** said crop articles location means which are rotatable at a different speed and in a different direction to the direction of travel of the roller conveyor.

7. Apparatus according to claim 5 **characterised in that** said crop articles location means which are rotatable at a different speed and in the same direction as the direction of travel of the roller conveyor

8. Apparatus according to claim 1 **characterised in that** said apparatus is provided with a plurality of crop article location means.

9. Apparatus according to claim 1 **characterised in that** said a portion of said roller conveyor comprises a plurality of rollers which are rotatable at a different speed and in a different direction to the remaining rollers of the conveyor.

10. Apparatus according to claim 9 **characterised in that** the movement of the plurality of rollers which are rotatable at a different speed and in a different direction to the remaining rollers of the conveyor acts to create a contra flow.

11. Apparatus according to claim 9 **characterised in that** plurality of rollers are positioned at a spaced location with respect to a crop article location means.

12. A method of inspecting and sorting crop articles such as fruit and vegetables comprising the steps of providing:

   a) at least one drivable roller conveyor onto which crop articles are presented;
   b) an inspection device under which the articles conveyed which inspects and scans the articles as they pass;
   c) a control system for analysing and processing the data obtained and adapted;
   d) article removal devices which may be actuated to displace/remove articles from the roller conveyor in response to the data; and
   e) at least one discharge location

   characterised by the further step of providing crop article location means which act on said crop articles to facilitate the positioning of same prior to inspection

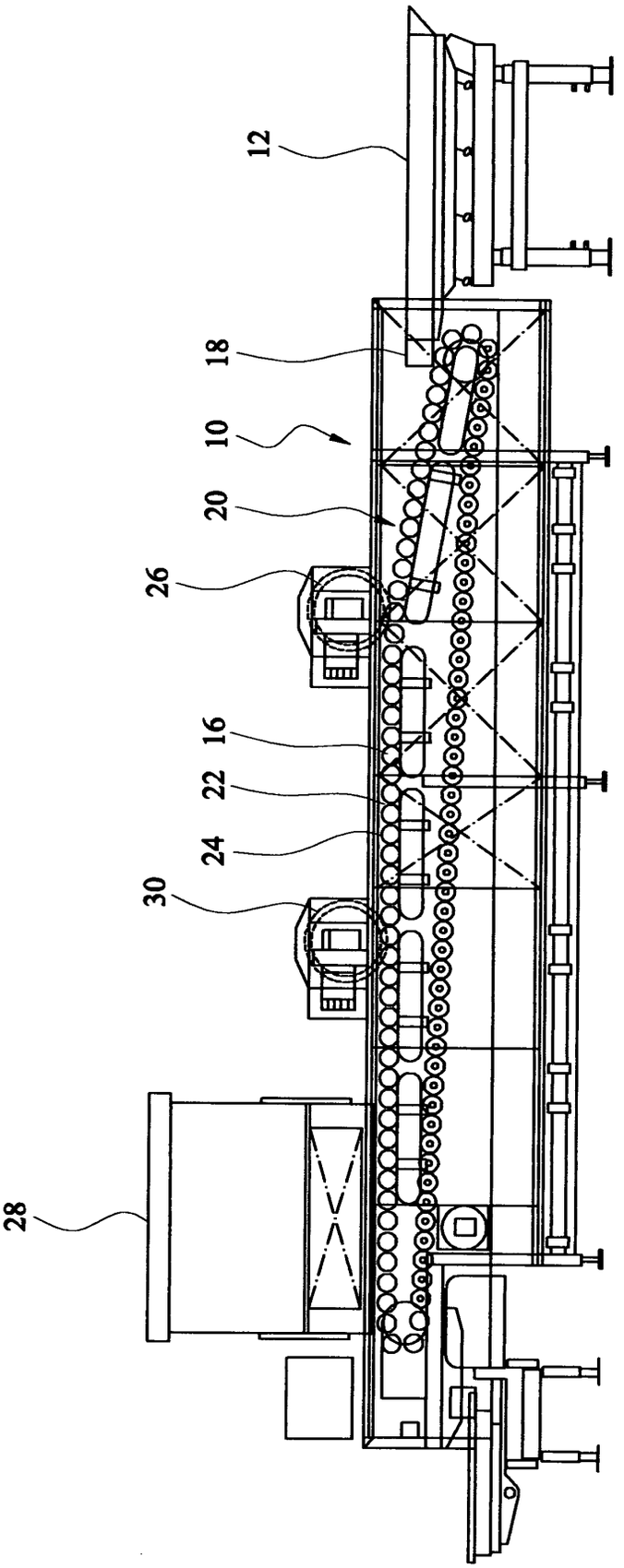

FIG. 1

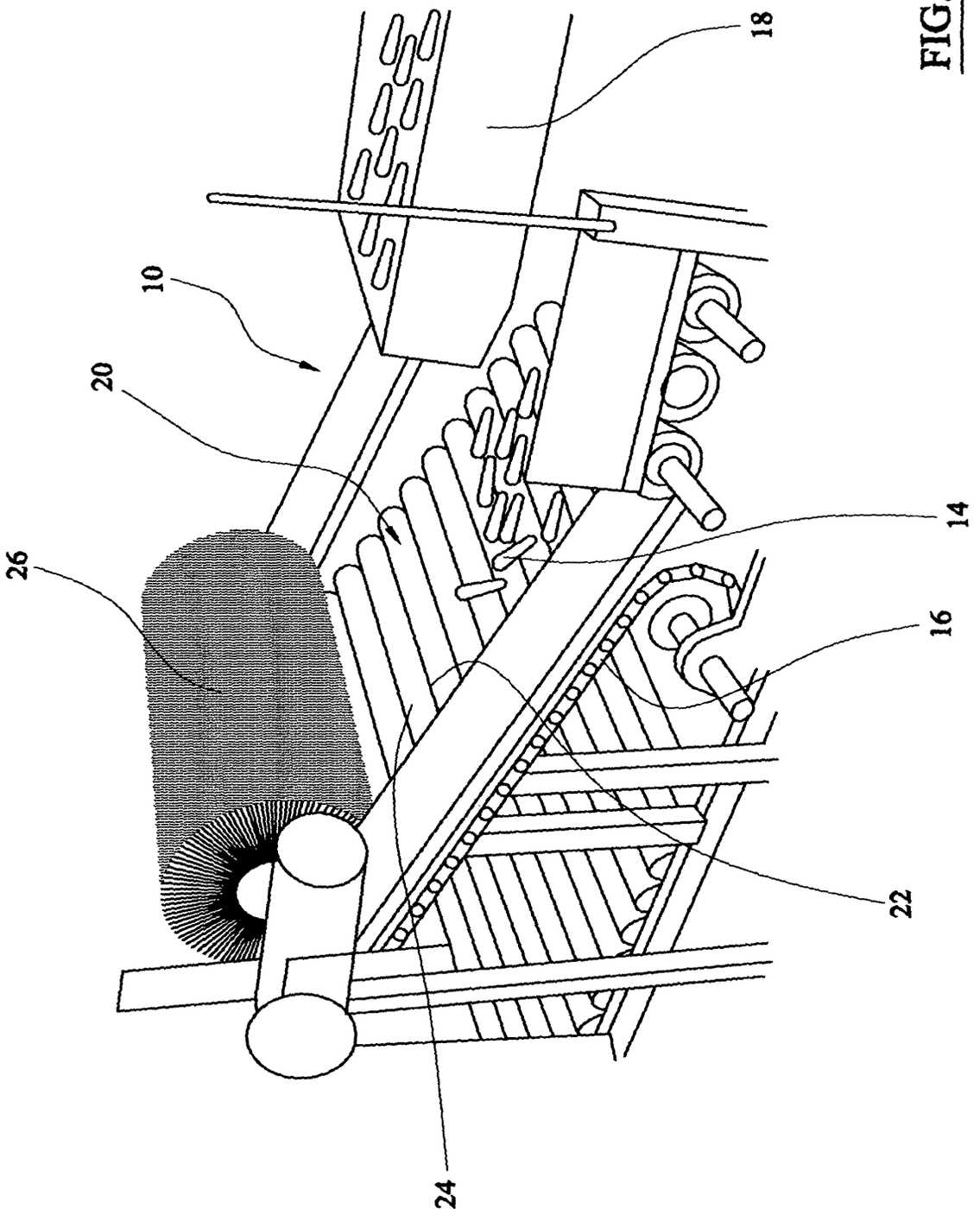

FIG. 2

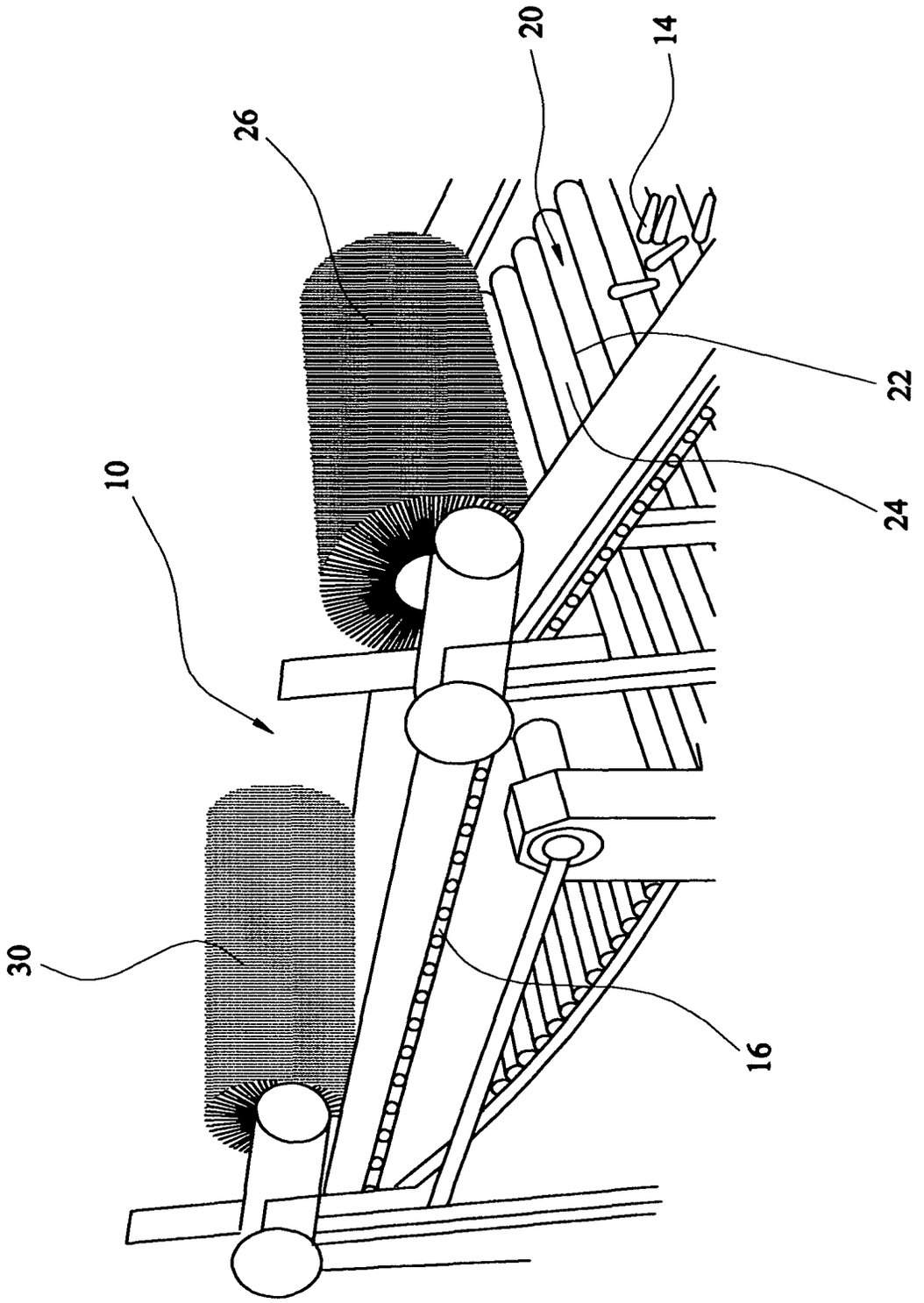

FIG. 3

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EUROPEAN SEARCH REPORT

Application Number
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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	9 June 2005	Wich, R

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