



(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
05.06.2019 Bulletin 2019/23

(51) Int Cl.:
B07C 5/36 (2006.01)
A24B 1/04 (2006.01)
B07C 5/342 (2006.01)

(21) Application number: **17205201.1**

(22) Date of filing: **04.12.2017**

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME
Designated Validation States:
MA MD TN

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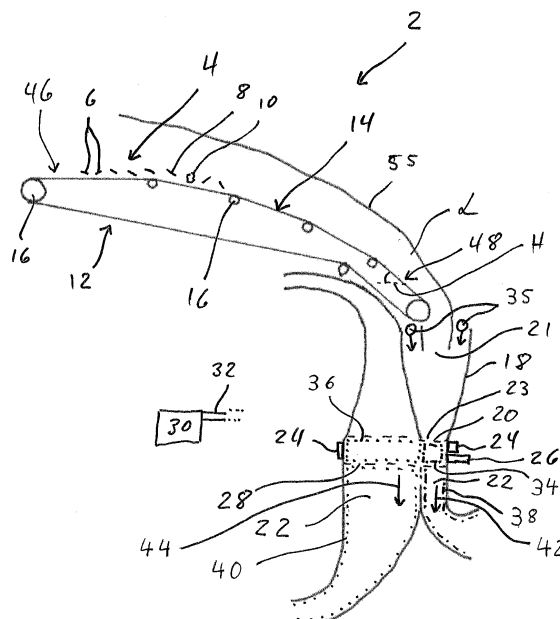
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(54) **SORTER IN THE TOBACCO INDUSTRY AND METHOD OF SORTING SUBSTANTIALLY FLAT AND LIGHTWEIGHT ARTICLES**

(57) The invention relates to a sorter (2) and a method in the tobacco industry. The sorter is for sorting a stream (4) of substantially flat and lightweight articles (6). It comprises an optical inspection apparatus (24) for finding non-conforming articles (10) in the stream (4) of articles (6) and an article removing apparatus (26) for removing the found non-conforming articles (10) from the stream (4) of articles (6). Furthermore, there is a sub-

stantially vertical duct (22), wherein the stream (4) of articles (6) enters the duct (22) at an upper opening (20) of the duct (22) and the optical inspection apparatus (24) and the removing apparatus (26) are arranged in an inspection and sorting area (28) of the duct (22). The sorter (2) comprises a blower apparatus (30), which is configured to generate a downwards air-flow (42, 44) in the vertical duct (22).

FIG. 1



Description

[0001] The invention relates to a sorter in the tobacco industry for sorting a stream of substantially flat and lightweight articles, comprising an optical inspection apparatus for finding non-conforming articles in the stream of articles and an article removing apparatus for removing the found non-conforming articles from the stream of articles, further comprising a substantially vertical duct, wherein the stream of articles enters the duct at an upper opening of the duct and the optical inspection apparatus and the removing apparatus are arranged in an inspection and sorting area of the duct.

[0002] Furthermore, the invention relates to a method of sorting substantially flat and lightweight articles in the tobacco industry, comprising the steps of feeding a stream of substantially flat and lightweight articles to an upper opening of a substantially vertical duct, inspecting the stream of articles by an optical inspection apparatus, removing non-conforming articles, which were found during inspection of the stream, by an article removing apparatus, wherein inspection and removal are performed in an inspection and sorting area of the duct.

[0003] Non-conforming articles in a stream of flat and lightweight articles, which is in particular a stream of tobacco particles, which can be pieces of cut or fresh tobacco leaves, may result from the production process that is agriculture based. It is also possible that non-conforming articles come from other sources or are products to be sorted out from the tobacco product such as parts cut from stems. A typical size of the particles ranges from a few millimeters to a few hundred millimeters. Since tobacco is a relatively expensive raw material, it is desirable, to design the selection process in that it only removes the non-conforming articles. In other words, the sorting process should be as selective as possible to remove only the undesired articles from the stream of articles.

[0004] The tobacco industry applies sorters for sorting out articles from a stream of tobacco articles. Document EP 1 838 464 B1 discloses a method and an apparatus for this purpose. The disclosed apparatus comprises a sorting facility having an optical inspection facility and a removal facility for removing the non-conforming articles from the stream of articles. The removal facility is gas driven. It removes the non-desired articles by pushing them with a gas jet in a direction, which is oriented transverse to the direction of the straight free falling movement of articles. The inspection facility is preceded by an orientation facility for orienting the stream of articles through a centrifugal force. An air suction force performs a transition of the initial horizontal movement to the movement in the vertical falling direction of the articles. The free falling articles are optically inspected. The gas driven operation of the removal facility removes non-conforming articles.

[0005] It is an object of the invention to provide a sorter in the tobacco industry for sorting a stream of substantially flat and lightweight articles and to provide a method

of sorting substantially flat and lightweight articles in the tobacco industry, wherein the sorter and the method should be enhanced with respect to the quality of the sorting.

[0006] The object is solved by a sorter in the tobacco industry for sorting a stream of substantially flat and lightweight articles, comprising an optical inspection apparatus for finding non-conforming articles in the stream of articles and an article removing apparatus for removing the found non-conforming articles from the stream of articles, further comprising a substantially vertical duct, wherein the stream of articles enters the duct at an upper opening of the duct and the optical inspection apparatus and the removing apparatus are arranged in an inspection and sorting area of the duct, wherein the sorter is further enhanced by a blower apparatus, which is configured to generate a downwards air-flow in the vertical duct.

[0007] Within the context of this specification, the term "optical inspection" refers to both, a visual inspection, for example using a camera, and a laser scanning process.

[0008] The design of the sorter is based on the following considerations: The stream of articles comprises articles of different size and weight. In other words, there is a large size and weight distribution in the stream of articles. In a situation, when this stream enters a duct and the individual particles fall free in ambient air, the greater and heavier particles will fall faster than the smaller and lighter particles. Each particle has an individual speed because its fall velocity under free fall conditions results from a balance between a downwards force, which is due to gravity and accelerates the particle, and the aerodynamic drag of the respective particle.

[0009] In other words, in the above explained situation, the greater and heavier particles will fall faster than the smaller and lighter particles. This also applies to the passage of the inspection and sorting area. As a result, there is the undesired effect that the path between the point of detection of the particle and the location at which the non-conforming article is ejected by the air blast, is passed through by greater and heavier articles in a shorter time than the same path is traveled by the smaller and lighter articles. This may result in a situation in which the ejection blast does not exactly hit the previously detected non-conforming article. This is because the detected article can be faster or slower than expected. The effect deteriorates the quality of the sorting.

[0010] The sorter according to aspects of the invention makes up for this deficiency by providing an airflow, which carries and in particular accelerates the particles downwards even in the detection and sorting area. In particular, the airflow accelerates the articles through the inspection and sorting area. The airflow carries away the small and light particles to give these particles a falling speed that is comparable to that of the greater and heavier particles. In other words, the airflow compensates for the influence of the aerodynamic drag on the light particles. The result of this technical measure is a situation

in which all particles, which means the smaller and lighter particles as well as the greater and heavier particles, perform a uniform downwards motion in the detection and sorting area. Advantageously, the delay time between detection and ejection of the non-conforming particles is almost the same for all particles, irrespective of their size and weight. Furthermore, there is no sideways movement of the particles. This positively influences the detection quality.

[0011] The advantageous effect is a significant enhancement of the sorting quality, which means that the probability that the air blast of the removing apparatus precisely hits the detected non-conforming article, increases significantly. The sorter has an enhanced efficiency and provides better sorting quality.

[0012] According to an advantageous embodiment, the sorter in the tobacco industry is further enhanced that the inspection and sorting area comprises a first section and a second section, wherein the duct is split in a first part and a second part downstream the inspection and sorting area, wherein particles in the first section enter the first part and particles in the second section enter the second part and wherein the blower apparatus, the first part and the second part are configured in that a first air-flow in the first section and a second air-flow in the second section of the inspection and sorting area have substantially the same velocity field.

[0013] When a non-conforming article is sorted out from the stream of articles, the air jet shifts it from the first section to the second section of the inspection and sorting area. In other words, the particle is urged to perform an almost horizontal movement, which is preceded by the downwards movement and which is continued by a downwards movement. Advantageously, the velocity field of the air, which is conducted through the inspection and sorting area in the first and in the second section, is uniform. When considering the movement of the non-conforming article in a reference system, which is moving together with the downwards streaming air, the particle performs an almost perfect linear horizontal movement. The uniform velocity field is advantageous because there is no distortion, i.e. no turbulence or the like, in the downward streaming air. Nonuniform motion could affect the ejection process in a negative way. The result of the mentioned technical measure is again a more efficient sorting process. In particular, the risk for undesired wrong matching of articles to the respective portion of the lower part of the duct is significantly reduced.

[0014] It is further advantageous when the sorter is enhanced in that the first section comprises the removing apparatus, which is configured to shift non-conforming articles from the first section to the second section, wherein the first part of the duct is for transporting conforming articles to subsequent treatment and the second part is for transporting non-conforming articles. This arrangement proved to be advantageous in practical applications.

[0015] In another advantageous embodiment of the in-

vention, the sorter is further enhanced by comprising an acceleration chute, which is arranged between a conveyor for transporting the stream of substantially flat and lightweight articles and the upper opening of the duct, wherein the acceleration chute is conical in shape and comprises an upper opening receiving the stream of articles from the conveyor and a lower opening having a smaller cross-section when compared to a cross-section of the upper opening.

[0016] In particular, the blower apparatus is configured in that it comprises air inlets which are arranged at or near to an upper opening of the acceleration chute. By injecting air at the upper opening of the acceleration chute in combination with the conical shape of the acceleration chute, an accelerated downstream airflow is realized.

[0017] The acceleration chute homogenizes the velocities of the different articles in the stream of articles. It is further advantageous to give the different articles some time and a trajectory having a certain length to adapt to the uniform falling velocity before the particles enter the inspection and sorting area and the ejection of the non-conforming articles is performed. The acceleration chute further enhances the quality of the sorting. Furthermore, the acceleration chute can be configured in that it accelerates the particles to a desired top speed, which can be a velocity, which is near to that of free falling velocity of the greater and heavier particles.

[0018] In still another advantageous embodiment, the conveyor has a transport surface carrying the stream of articles, wherein the transport surface bends from a substantially horizontal direction at a start portion of the conveyor to a tilted direction at an end portion of the conveyor, at which the stream enters the upper opening of the acceleration chute, wherein the end portion of the transport surface includes an angle with a vertical direction, which is between 30° to 70°, in particular between 55° and 65°.

[0019] Feeding the stream of articles into the vertical duct or, in particular, into the upper opening of the acceleration chute, using a conveyor having a bent or curved transport surface turned out to be advantageous. It is in particular advantageous when the transport surface, in its end portion, includes an angle with a vertical direction, which is in the given range. Due to the inclined transport surface, the movement vector of the particles on the transport surface gains a vertical component. In other words, the stream of articles is not inserted into the vertical duct or into the acceleration chute starting with an exclusive horizontal movement. Homogenization of the vertical velocity of all particles already starts on the transport surface of the conveyor. This technical measure is also advantageous for enhancing the quality of the sorting process.

[0020] The object is further solved by a method of sorting substantially flat and lightweight articles in the tobacco industry, comprising the steps of feeding a stream of substantially flat and lightweight articles to an upper opening of a substantially vertical duct, inspecting the

stream of articles by an optical inspection apparatus, removing non-conforming articles, which were found during inspection of the stream, by an article removing apparatus, wherein inspection and removal are performed in an inspection and sorting area of the duct, wherein the method is further enhanced by the step of generating a downwards air-flow in the vertical duct by a blower apparatus, wherein the air-flow accelerates the articles in the inspection and sorting area.

[0021] Same or similar advantages, which have been mentioned with respect to the sorter above, also apply to the method according to aspects of the invention. In view of this, repetitions shall be omitted. In the method according to aspects of the invention, a high quality sorting process is provided, wherein the undesired effect of different falling velocities in the inspection and sorting area is avoided.

[0022] The method is further enhanced in that the inspection and sorting area comprises a first section and a second section, wherein the duct is split in a first part and a second part downstream the inspection and sorting area, and wherein particles in the first section enter the first part and particles in the second section enter the second part and wherein a first air-flow in the first section and a second air-flow in the second section of the inspection and sorting area are generated by the blower apparatus and the first air-flow and the second air-flow have substantially the same velocity field.

[0023] According to another advantageous embodiment, the first section comprises the removing apparatus, which shifts non-conforming articles from the first section to the second section, wherein the first part of the duct transports conforming articles to subsequent treatment and the second part transports non-conforming articles.

[0024] For a further homogenizing, the velocity distribution of the different articles in the stream of articles which passes through the inspection and sorting area, the method is further enhanced by accelerating the stream of substantially flat and lightweight articles in an acceleration chute, which is arranged between a conveyor for transporting the stream of articles and the upper opening of the duct, wherein the acceleration chute is conical in shape and comprises an upper opening receiving the stream of articles from the conveyor and a lower opening having a smaller cross-section when compared to a cross-section of the upper opening.

[0025] In still another advantageous embodiment, the method comprises the step of transporting the stream of articles on a transport surface of a conveyor, wherein the transport surface bends from a substantially horizontal direction at a start portion of the conveyor to a tilted direction at an end portion of the conveyor, at which the stream enters the upper opening of the acceleration chute, wherein the stream of articles enters the upper opening of the acceleration chute at an angle, which includes 30° to 70°, in particular 55° to 65°, with a vertical direction.

[0026] The airflow can be injected using for example

air inlets, at an upper opening of the acceleration chute or at an upper opening of the substantially vertical duct. This applies to all above-named embodiments.

[0027] Further characteristics of the invention will become apparent from the description of the embodiments according to the invention together with the claims and the included drawings. Embodiments according to the invention can fulfill individual characteristics or a combination of several characteristics.

[0028] The invention is described below, without restricting the general intent of the invention, based on exemplary embodiments, wherein reference is made expressly to the drawings with regard to the disclosure of all details according to the invention that are not explained in greater detail in the text. The drawings show in:

FIG. 1 a simplified cross-sectional schematic drawing showing a part of the sorter,

FIG. 2 a simplified cross-sectional drawing showing an acceleration chute and a conveyor having a band transport surface and

FIG. 3 a simplified schematic detailed drawing illustrating the inspection and sorting area of the sorter, which is arranged in a part of the vertical duct.

[0029] In the drawings, the same or similar elements or respectively corresponding parts are provided with the same reference numbers in order to prevent the item from needing to be reintroduced.

[0030] In FIG. 1, there is a simplified schematic drawing showing a part of a sorter 2 in the tobacco industry. The device is for sorting a stream 4 of substantially flat and lightweight articles 6. For clarity reasons, only a few of the articles 6 are provided with reference numerals. The flat and lightweight articles 6 are for example pieces of cut or fresh tobacco leafs. As a result of for example the production process of these articles 6, the stream of articles 6 comprises conforming articles 8 and non-conforming articles 10. The conforming articles 8 are for example parts of the tobacco leaf (lamina) while the non-conforming articles 10 may have other sources or can be parts of cut stems and the like. Non-conforming articles 10 are non-tobacco related materials or, for example, discolored tobacco leafs. The typical size of the particles 6 ranges from a few millimeters to a few hundred millimeters. The stream 4 of articles 6 is transported by a conveyor 12, which is for example a band conveyor. The conveyor 12 has a transport surface 14, which is defined by an upper surface of, for example, the band of the band conveyor. The band is guided via several guide pulleys 16. Again, only a few of the guide pulleys 16 are provided with a reference numeral for the sake of clarity. In particular, the stream 4 of articles 6 is a monolayer of articles 6, which means that the articles 6 do ideally not overlap each other.

[0031] The sorter 2 further comprises an acceleration chute 18, which is arranged between the conveyor 12 and an upper opening 20 of a substantially vertical duct 22. In the duct 22, there is an optical inspection apparatus 24, which is configured for finding non-conforming articles 10 in the stream 4 of articles 6. Furthermore, there is an article removing apparatus 26 for removing the found non-conforming articles 10 from the stream 4 of articles 6. Further details of the optical inspection apparatus 24 and the article removing apparatus 26 will be explained further below.

[0032] The stream 4 of articles 6 enters the substantially vertically oriented duct 22 at an upper opening 20, wherein directly downstream to this upper opening 20, there is an inspection and sorting area 28 (surrounded by a dashed line) in the duct 22. The optical inspection apparatus 24 and the article removing apparatus 26 are arranged in this inspection and sorting area 28. Within the context of this specification, "comprising" with respect to the optical inspection apparatus 24 and the removing apparatus 26 means that optical inspection apparatus 24 and the removing apparatus 26, respectively, are configured or arranged in that detection and ejection of particles can be performed in the inspection and sorting area 28. The device itself must of course not be entirely arranged in the inspection and sorting area 28.

[0033] The sorter 2 further comprises a blower apparatus 30, which is schematically illustrated and which is configured to generate a downwards airflow, which is indicated by arrows pointing downwards in FIG. 1. This downwards airflow is generated in the vertical duct 22, in particular in the inspection and sorting area 28. For feeding air in the vertical duct 22, the blower apparatus 30 is connected to a pipe system 32, which is only partly illustrated in FIG. 1. This pipe system 32 connects inter alia two air inlets 35, which are arranged at or near by an upper opening 21 of the acceleration chute 18, with the blower apparatus 30. The air inlets 35 are for feeding the downwards airflow into the acceleration chute 18 and in the vertical duct 22. The acceleration chute 18 is conical in shape and comprises an upper opening 21 receiving the stream 4 of articles 6 from the conveyor 12. A lower opening 23 of the acceleration chute 18 (the lower opening 23 of the acceleration chute 18 can be almost identical to the upper opening 20 of the substantially vertical duct 22) has a smaller cross section when compared to a cross section of the upper opening 21 of the acceleration chute 18. The conical shape and the reduction of the cross section accelerate the air, which is fed into the acceleration chute 18 via the air inlets 35 from the upper opening 21 to the lower opening 23. This acceleration advantageously homogenizes the velocities of the different articles 6. The articles 6 are in particular accelerated to a speed, which is the speed of the falling of the heavier articles. As a result of this, all articles have the same velocity, irrespective of their size and weight.

[0034] The inspection and sorting area 28 (indicated by a dashed line) comprises a first section 34, which is

surrounded by a dash-dotted line, and a second section 36, which is surrounded by a dotted line. The duct 22 is split in a first part 38, which is also surrounded by a dash-dotted line, and in a second part 40 being surrounded by a dotted line. The first part 38 and the second part 40 are arranged downstream the inspection and sorting area 28. Particles 6 in the first section 34 enter the first part 38 and particles 6 in the second section 36 enter the second part 40.

[0035] The first part 38 and the second part 40 continue further downstream the inspection and sorting area 28. In the second part 40, non-conforming articles 10 are transported to further treatment, which is not depicted. In the first part 38, the conforming articles 8, which are for example parts of tobacco leaves, are fed to further processing steps, which are also not illustrated. The conforming articles 8, which are transported in the first part 38 are for example fed to a speed reducing chamber and to a discharge section, which can be a further band conveyor. The non-conforming articles 10, which are fed through the second part 40, are transported for example to non-tobacco related material further treatment. The first part 38 and the second part 40 can be divided by a mesh, which can be adjustable, in longitudinal direction, which means substantially parallel to the air flow in the duct 22.

[0036] The blower apparatus 30 including the connected piping system 32 and the air inlets 35 as well as the first part 38 and the second part 40 are configured in that a first air flow 42 and a second air flow 44 have substantially the same velocity field. This applies in particular to a first air flow 42 in the first section 34 and to a second air flow 44 in the second section 36 of the inspection and sorting area 28. Only for the sake of clarity, the arrow indicating the first air flow 42 and the arrow indicating the second air flow 44 are illustrated in FIG. 1 in the first part 38 and in the second part 40, respectively. This illustration is also true since the first air flow 42 in the first section 34 and in the first part 38 as well as the second air flow 44 in the second section 36 and the second part 40 are substantially identical.

[0037] The sorter 2 is configured in that the first section 34 comprises the removing apparatus 26, which is configured to shift non-conforming articles 10 from the first section 34 to the second section 36. Within the context of this specification, "comprising" means that the removing apparatus 26 is configured or arranged in that it can eject particles from the first section 34 to the second section 36. The apparatus itself must of course not be entirely arranged in the first section 34. For example, the removing apparatus 26 is an air blast apparatus operating as an ejector pushing the non-conforming articles 10 from the first section 34 to the second section 36 of the inspection and sorting area 28 by an air jet. The first part 38 of the duct 22, which is arranged downstream the first section 34 of the inspection and sorting area 28 is for transporting conforming articles 8 to a subsequent treatment. The second part 40, which is arranged downstream

the second section 36, is for transporting the non-conforming articles 10.

[0038] Advantageously, the first air flow 42 and the second air flow 44 have or represent the same velocity field of air, which means that the movement of the downwards streaming air is homogeneous in the first section 34 and the second section 36. There are no turbulences. This is advantageous when urging the non-conforming particles 10 from the first section 34 to the second section 36, which enhances the quality of sorting.

[0039] The sorting quality is enhanced by giving all particles 6 the same velocity and by omitting horizontal movement of the particles 6 in the downwards streaming air. The detection of the non-conforming articles 10 by the optical inspection apparatus 24, which can be for example a camera, and the subsequent ejection of the non-conforming particles 10 using the article removing apparatus 26 is highly predictable since the path of the downwards traveling articles 10 is independent of their size and weight.

[0040] The quality of sorting can be further enhanced by application of a conveyor 12 having a curved transport surface 14 as it is illustrated in FIG. 1. The transport surface 14, which carries the stream 4 of articles 6, bends from a substantially horizontal direction in a start portion 46 to a tilted direction at an end portion 48. At this end portion 48, the stream 4 of articles 6 leaves the conveyor 12 and enters the upper opening 21 of the acceleration chute 18. The end portion 48 of the transport surface 14 includes an angle α with a horizontal direction H. The angle α is between 30° and 70°, in particular, the angle α is between 55° and 65°. Due to the inclined end portion 48, the articles 6, which are transported on the transport surface 14 of the conveyor 12, receive a component in their velocity vector, which is directed downwards. In other words, the articles 6 enter the upper opening 21 of the acceleration chute 18 not with zero speed in vertical direction but with a certain initial velocity in this vertical direction. This homogenizes the vertical speed of the different articles. The particular range of the angle α has proven to be advantageous because a compromise has to be found between non-slipping of the articles 6 on the transport surface 14 on the one hand and a maximum acceleration in downwards direction on the other hand.

[0041] In FIG. 2, there is a simplified cross sectional drawing showing the acceleration chute 18 in more detail. Furthermore, the end portion 48 of the band conveyor 12 is visible. This end portion 48 includes an angle α with the horizontal direction H, which is between 30° and 70°. In the depicted embodiment, the angle α is approximately between 55° and 65°. At a backside, the band conveyor 12 comprises a brush 50 for removing articles, which adhere to the transport surface 14 of the band conveyor 12.

[0042] The stream of articles 4, which is illustrated by arrows in FIG. 2, enters an upper opening 21 of the acceleration chute 18. The articles 6 (see FIG. 1) are accelerated in the acceleration chute 18 on a path having

the length h. The acceleration is performed by downstream air, which is inserted via the air inlets 35. In addition to this, the air stream 52, which is also illustrated by arrows, can be guided along the transport surface 14 of the conveyor 12. For this purpose, there is a hood 55, which can be adjustable so as to widen or narrow the distance D0.

[0043] The acceleration chute 18 is conical in shape, which means that the upper opening 21 having the diameter D1, is larger than the lower opening 23, which has the diameter D2. The air stream 52 accelerates the stream of articles 4 in that larger and smaller articles leave the acceleration chute 18 with uniform velocity.

[0044] In FIG. 3 there is a simplified schematic more detailed drawing illustrating the inspection and sorting area 28, which is arranged in the vertical duct 22. The stream of articles 4, which is again illustrated by an arrow, enters the inspection and sorting area 28 at an upper opening 20 together with the supporting air stream 52.

The inspection and sorting area 28 comprises a first section 34, which is surrounded by a dash-dotted line, and a second section 36, which is surrounded by a dotted line. The stream of articles 4 enters the first section 34 and in this first section 34, an optical inspection of the articles 6 is performed by an optical inspection apparatus 24. By way of an example, the optical inspection apparatus 24 comprises a front camera 54 sensing the articles 6 in front of a background 56 and a rear camera 58 also sensing the articles 6 in front of a background 56. Other optical inspection devices can be applied if suitable.

[0045] The stream of articles 4 performs a uniform downwards motion through the inspection and sorting area 28, wherein light and small particles fall as fast as heavier and greater particles 6. The uniform downwards motion can be supported by additional air inlets 60, which can be arranged near the upper opening 20 of the vertical duct 22. Detected non-conforming articles 10 are removed from the stream 4 of articles 6 by an article removing apparatus 26, which is an air driven ejector urging the non-conforming article 10 from the first section 34 to the second section 36. The shifted non-conforming article 10 is given the references numeral 10'. This horizontal movement is illustrated by an arrow.

[0046] For catching very fast removed articles 10, there can be an anti repercussion surface 61 in the vertical duct 22. A detailed view of this anti repercussion surface 61 is given as an inset in FIG. 3, the inset showing a cross section along the plane A-A. The anti repercussion surface 61 can be a faceted surface. Articles 6, which are not removed from the first section 34 enter the first part 38 of the vertical duct 22. This first part 38 is also surrounded by a dash-dotted line. The conforming articles 8 can be transported via a speed reducing chamber 62 to a further conveyer 64. The non-conforming articles 10, which are pushed by the article removing apparatus 26 to the second section 36 enter the second part 40, which is surrounded by a dotted line. The first part 38 and the second part 40 are divided by a mesh 66, which

can be adjustable in height as illustrated by a double arrow. In the inspection and sorting area 28, the first air flow 42 in the first section and the second air flow 44 in the second section have the same velocity field as already explained above.

[0047] All named characteristics, including those taken from the drawings alone, and individual characteristics, which are disclosed in combination with other characteristics, are considered alone and in combination as important to the invention. Embodiments according to the invention can be fulfilled through individual characteristics or a combination of several characteristics. Features that are combined with the wording "in particular" or "especially" are to be treated as preferred embodiments.

List of reference numbers

[0048]

2	sorter
4	stream of articles
6	articles
8	conforming articles
10, 10'	non-conforming articles
12	conveyor
14	transport surface
16	guide pulleys
18	acceleration chute
20, 21	upper opening
22	duct
23	lower opening
24	optical inspection apparatus
26	article removing apparatus
28	inspection and sorting area
30	blower apparatus
32	pipe system
34	first section
35	air inlets
36	second section
38	first part
40	second part
42	first air flow
44	second air flow
46	start portion
48	end portion
50	brush
52	air stream
54	front camera
55	hood
56	background
58	rear camera
60	air inlets
61	anti reperussion surface
62	speed reducing chamber
64	further conveyor
66	mesh
α	angle

H	horizontal direction
h	length
D0	distance
D1, D2	diameter

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Claims

1. A sorter (2) in the tobacco industry for sorting a stream (4) of substantially flat and lightweight articles (6), comprising an optical inspection apparatus (24) for finding non-conforming articles (10) in the stream (4) of articles (6) and an article removing apparatus (26) for removing the found non-conforming articles (10) from the stream (4) of articles (6), further comprising a substantially vertical duct (22), wherein the stream (4) of articles (6) enters the duct (22) at an upper opening (20) of the duct (22) and the optical inspection apparatus (24) and the removing apparatus (26) are arranged in an inspection and sorting area (28) of the duct (22), **characterized by** a blower apparatus (30), which is configured to generate a downwards air-flow (42, 44) in the vertical duct (22).
2. The sorter (2) in the tobacco industry according to claim 1, **characterized in that** the inspection and sorting area (28) comprises a first section (34) and a second section (36), wherein the duct (22) is split in a first part (38) and a second part (40) downstream the inspection and sorting area (28), and wherein particles (6) in the first section (34) enter the first part (38) and particles (6) in the second section (36) enter the second part (40) and wherein the blower apparatus (30), the first part (38) and the second part (40) are configured **in that** a first air-flow (42) in the first section (34) and a second air-flow (44) in the second section (36) of the inspection and sorting area (28) have substantially the same velocity field.
3. The sorter (2) in the tobacco industry according to claim 2, **characterized in that** the first section (34) comprises the removing apparatus (26), which is configured to shift non-conforming articles (10) from the first section (34) to the second section (36), wherein the first part (38) of the duct (22) is for transporting conforming articles (8) to subsequent treatment and the second part (40) is for transporting non-conforming articles (10).
4. The sorter (2) in the tobacco industry according to one of claims 1 to 3, **characterized by** an acceleration chute (18), which is arranged between a conveyor (12) for transporting the stream (4) of substantially flat and lightweight articles (6) and the upper opening (20) of the duct (22), wherein the acceleration chute (18) is conical in shape and comprises an upper opening (21) receiving the stream (4) of articles (6) from the conveyor (12) and a lower opening

(23) having a smaller cross-section when compared to a cross-section of the upper opening (21).

5. The sorter (2) in the tobacco industry according to one of claims 1 to 4, **characterized in that** the conveyor (12) has a transport surface (14) carrying the stream (4) of articles (6), wherein the transport surface bends from a substantially horizontal direction at a start portion (46) of the conveyor (12) to a tilted direction at an end portion (48) of the conveyor (12), at which the stream (4) enters the upper opening (21) of the acceleration chute (18), wherein the end portion of the transport surface (14) includes an angle (α) with a horizontal direction (H), which is between 30° to 70°, in particular between 55° and 65°. 5 10
6. A method of sorting substantially flat and lightweight articles (6) in the tobacco industry, comprising the steps of feeding a stream (4) of substantially flat and lightweight articles (6) to an upper opening (20) of a substantially vertical duct (22), inspecting the stream (4) of articles (6) by an optical inspection apparatus (24), removing non-conforming articles (10), which were found during inspection of the stream (4), by an article removing apparatus (26), wherein inspection and removal are performed in an inspection and sorting area (28) of the duct (22), **characterized by** the step of generating a downwards air-flow (42, 44) in the vertical duct (22) by a blower apparatus (30), wherein the air-flow (42, 44) accelerates the articles (6) in the inspection and sorting area (28). 20 25 30
7. The method according to claim 6, **characterized in that** the inspection and sorting area (28) comprises a first section (34) and a second section (36), wherein the duct (22) is split in a first part (38) and a second part (40) downstream the inspection and sorting area (28), and wherein particles (6) in the first section (34) enter the first part (38) and particles (6) in the second section (36) enter the second part (40) and wherein a first air-flow (42) in the first section (34) and a second air-flow (44) in the second section (36) of the inspection and sorting area (28) are generated by the blower apparatus (30) and the first air-flow (42) and the second air-flow (44) have substantially the same velocity field. 35 40 45
8. The method according to claim 7, **characterized in that** the first section (34) comprises the article removing apparatus (26), which shifts non-conforming articles (10) from the first section (34) to the second section (36), wherein the first part (38) of the duct (22) transports conforming articles (8) to subsequent treatment and the second part (40) transports non-conforming articles (10). 50 55
9. The method according to one of claims 6 to 8, **characterized by** accelerating the stream (4) of substan-

tially flat and lightweight articles (6) in an acceleration chute (18), which is arranged between a conveyor (12) for transporting the stream (4) of articles (6) and the upper opening (20) of the duct (22), wherein the acceleration chute (18) is conical in shape and comprises an upper opening (21) receiving the stream (4) of articles (6) from the conveyor (12) and a lower opening (23) having a smaller cross-section when compared to a cross-section of the upper opening (21).

10. The method according to one of claims 6 to 9, **characterized by** transporting the stream (4) of articles (6) on a transport surface (14) of a conveyor (12), wherein the transport surface (14) bends from a substantially horizontal direction at a start portion (46) of the conveyor (12) to a tilted direction at an end portion (48) of the conveyor (12), at which the stream (4) enters the upper opening (21) of the acceleration chute (18), wherein the stream (4) of articles (6) enters the upper opening (21) of the acceleration chute (18) at an angle (α), which includes 30° to 70°, in particular 55° to 65°, with a horizontal direction (H).

FIG. 1

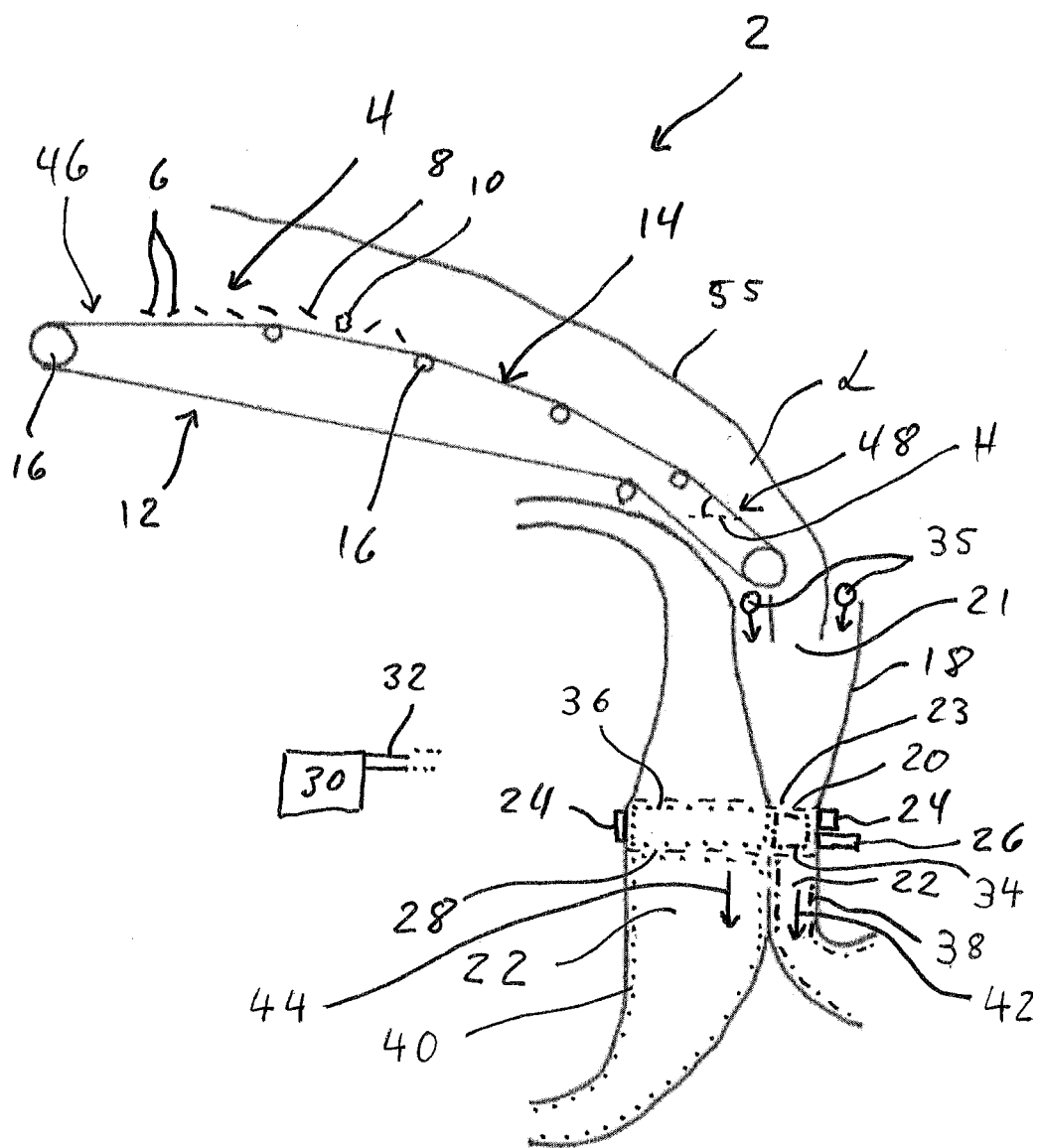


FIG. 2

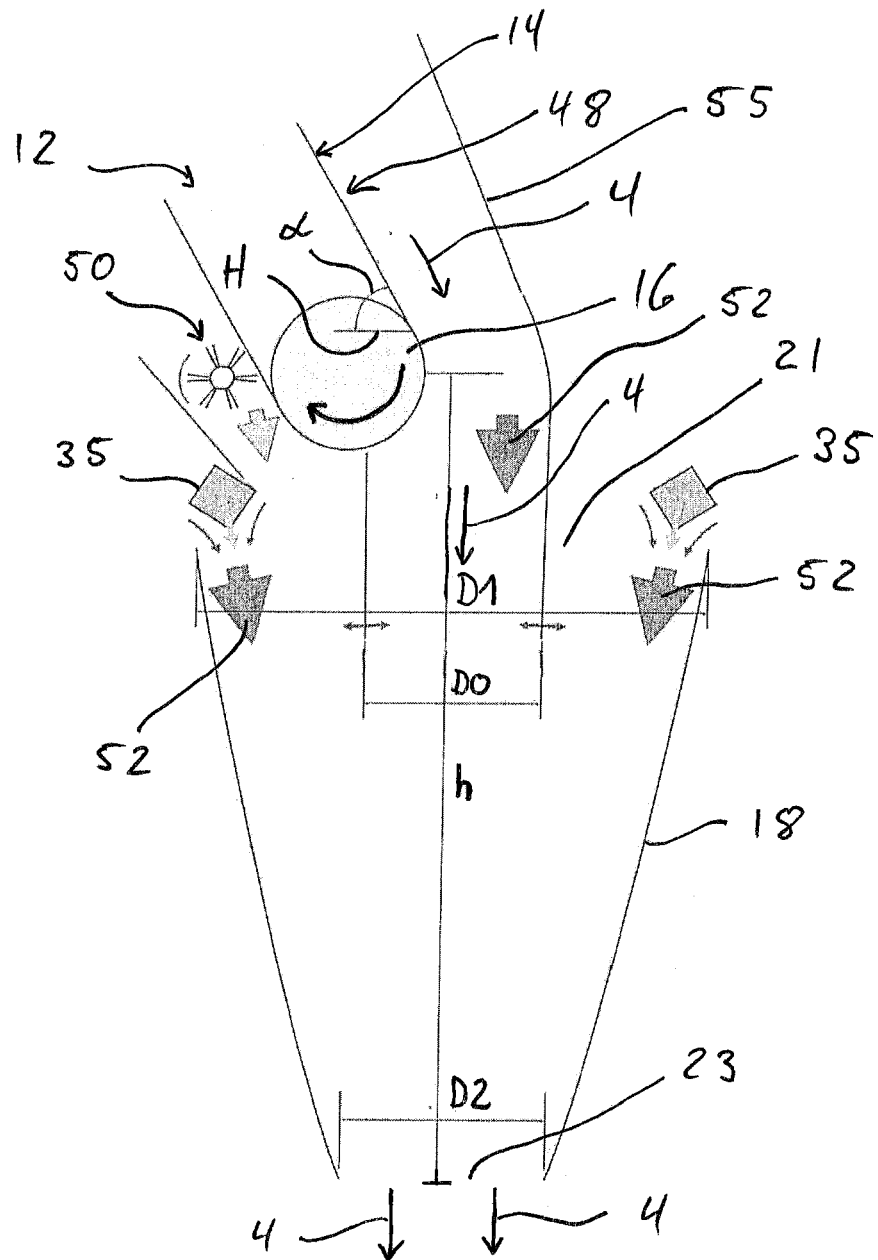
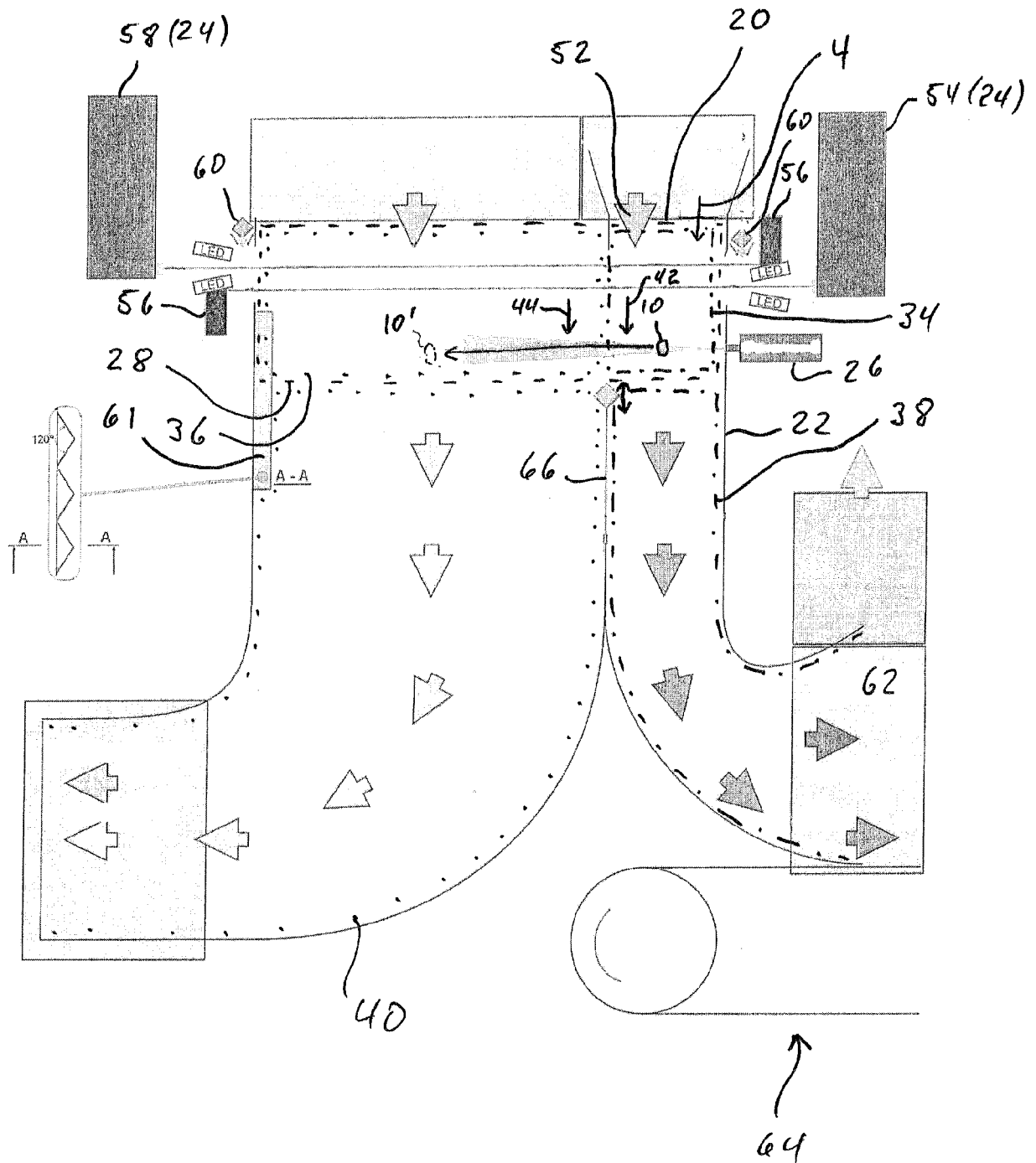


FIG. 3





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