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(54) Title: PRODUCT FLOW CONTROL APPARATUS FOR SORTING

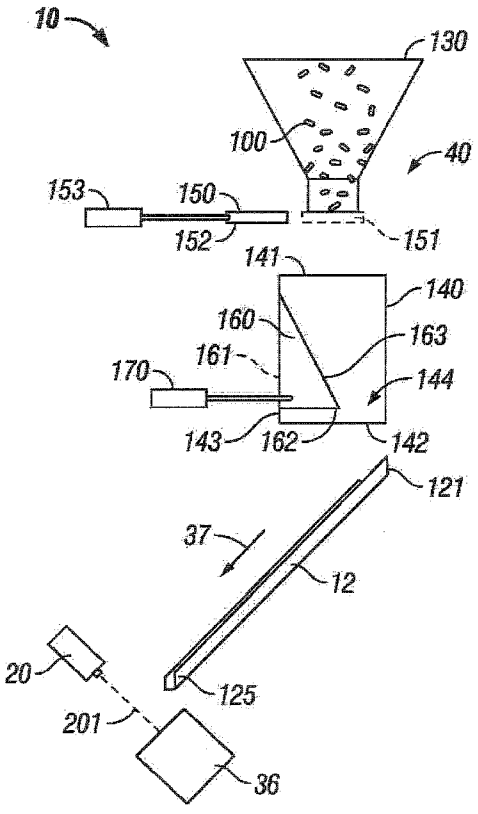


FIG. 3

(57) Abstract: A product flow control apparatus (40) for use in sorting of products (100), and particularly relatively small products. The apparatus (40) includes a reservoir (130) of products (100) to be sorted, a flow-rate control passage (140) at which a flow restrictor (160) limits the flow rate of products (100) passing to a slide (12) before imaging by a product viewer (20) and sorting by ejector (36). A flow valve (150) operates to provide products (100) to a flow-rate control passage (140) at a flow rate at which the product viewer (20) and the ejector (36) can operate.

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

TITLE OF THE INVENTION

[0001] Product flow control apparatus for sorting

BACKGROUND OF THE INVENTION

Field of Invention

[0002] The present invention relates to product delivery systems particularly suited for in gravitationally-fed sorters of transversely-spaced products moving along a direction of travel, which sorters separate transversely spaced products according to differences in their characteristics. In particular, the invention relates to a product flow control apparatus controlling the flow rate of products to be sorted, flowing at high rates induced by gravity which may be used in connection with relatively small, granular products to increase product density through the sorting machine and to increase sorting efficiency.

Description of the Related Art

[0003] A typical sorting machine of the type envisioned for application of the present invention is a gravity-fed high-speed sorting machine used for sorting small products, including fungible products in the food and pharmaceutical industries. For example, individual rice grains may be sorted to separate grains selected as “substandard.” In the art, “substandard” may apply to a grain having any undesirable characteristic, including color, shape, size or breakage, or any other characteristic not within the limits for acceptable products for a particular sorting. As used, product refers generally to the entirety of the item to be sorted, but may also be used to refer to an individual item.

[0004] Such a sorter incorporates a slide or chute at a steep angle having one or more channels across its width. A hopper or other feed system is positioned to dispense its product on the top of the slide. Gravity slide sorters have been in use for many years, sorting a wide variety of food products and many non-food products as well. Early sorters were single channel units, with a flat, “J,” "U"-, or "V"-shaped slide conveying product to a viewing area. Later, larger sorters were developed with 2, 6, 8, 12, etc., individual slides on a single frame. These individual slides were similar to the slides used on the single channel units, but economies were gained by constructing multiple slides on a single frame. These sorters presented multiple linear streams, or "strings", of product to be viewed.

[0005] If multiple channels are used, the slide is divided across its width and configured so that an approximately evenly proportioned number of dispensed products are

directed to each of the channels. Such techniques of distributing to each channel the proper amount of product being dispensed onto the slide are well-known in the art. A typical slide has numerous channels that may number as high as 64 or more, although slides for many machines in service today have only a limited number of channels, like 8, and in some applications it is preferable to use a single channel.

[0006] In the early 1980's, in response to the need for higher capacity sorters and to the need to sort products which would not flow smoothly down a slide, flat belt sorters were introduced. These sorters presented a wide sheet of product to the viewer.

[0007] In the mid-1980's a type of sorter was introduced which combined the simplicity and space efficiency of the discreet channel sorter with the high throughput capability of the belt sorter. These "broad slide" sorters presented multiple flat streams of product to the viewer. The total throughput of these multiple flat streams was often equal to the throughput of competing belt sorters.

[0008] Successful sorters have been developed for cereal grains using wide, flat slides, which present a "sheet" of product to the viewer/ejector system. The purpose of the slide is to accelerate and singulate the product, and to present it uniformly into the viewing area. This is similar to the product presentation of the belt sorter. Other successful sorters have been developed using slides that are also wide and flat, but in addition, have a series of dividing ribs separating the sheet of product into a series of "ribbons" of product, one per channel. These ribbons are presented to the viewer/ejector system oriented so that each ribbon passes in front of only one ejector. This important feature eliminates the condition of a defective product or article passing through the viewer in a location that causes two adjacent ejectors to fire at the same product, which often ejects an excessive amount of acceptable product along with the unacceptable. Logically, by eliminating the condition of product flowing through the zone of more than one ejector, a slide divided into channels, as just described, results in fewer total ejector fires and the removal of less good product.

[0009] Standard gravity-fed sorting machines, by virtue of requiring conveyance to the slide, require the product be transported laterally and cast onto the slide or guide. As a result, in the standard sorting machine the product may be impelled against a solid surface, in the case of a front conveyance system or enter the slide a low downward velocity on a path to contact the guide, in the case of a rear conveyance system. In operation, the gravity-fed products to be sorted are fed from a hopper, which feeds to the slide through a dividing

vibratory feeder. The vibratory feeder is integrated within the sorting machine, but is sufficiently isolated to reduce vibration of the remainder of the sorting machine. Product then passes down the slide and before the viewer/ejector system, where each product is imaged, compared to sort criteria and then allowed to pass or deflected by the ejector system. Problematically, when first activated, the volume of products induced by the vibratory feeder to the slide, and therefore before the viewer/ejection system due to lack of uniform velocity and product singulation lacks a complete set of targets for sorting. Often machine users discard these initial sort results as lacking accuracy. Likewise, after the vibratory feeder ceases or when the product supply is exhausted, products to which the vibratory feeder has already imparted motion may be carried by momentum to the slide opening after vibratory feeder shutdown. Unacceptable products within this product group may not be sorted properly as a result of lack of uniform product velocity, alignment and singulation. In a typical sorting machine configuration unacceptable product in this additional amount may not be ejected from the product flow. The effect of this unacceptable flow is sometimes referred to as the "dribble effect." As a result, unacceptable product, or contaminants, may be included in otherwise acceptable product. Finally, cessation of the vibratory feeder or exhaustion of the product supply may result in product being stranded intermediate the product supply and the slide, requiring the machine to be configured for operation to expel the unprocessed product, particularly if a different product is to be sorted.

[0010] Moreover, external vibrations may cause induce product flow, even in miniscule amounts, during times when the machine is not in operation, potentially contaminating sorted product.

[0011] Finally, the density of the product at the scan line, the point at which the sorting machine analyzes and determines whether any individual product is outside permissible parameters, drives the throughput of the sorting machine. Determination of whether the product is outside permissible paramters is accomplished by various optical equipment known in the art, such as cameras. Identification of an individual product outside of permissible parameters causes the sorter to cause an ejector to fire at the time the identified individual product will pass before the ejector. It is therefore advantageous to increase the density of the product passing through the sorting machine to the maximum density at which the optical equipment can image the passing product as this increases the throughput of the sorting machine, a desirable characteristic in the market as more product can therefore be

processed.

[0012] The need therefore exists for a product control system which eliminates the lack of full through-put at start-up, eliminates the dribble effect, eliminates the potential for stranded material at shutdown, and eliminates potential contamination caused by external vibration, all while having no negative effect of through-put rate. It would be a further improvement if the product through-put were increased.

BRIEF SUMMARY OF THE INVENTION

[0013] The present invention overcomes the foregoing drawbacks of previous product control systems.

[0014] In one aspect of the present invention, the vibratory feeder, or like motion inducing devices, are replaced with a product reservoir, a high-speed control gate, and an controllable feed-rate metering gate. The high-speed control gate is located at the bottom of the product reservoir, providing for gravity-induced feed of the products when the high-speed control gate is opened. The controllable feed-rate metering gate limits the maximum feed-rate of the products after the high-speed control gate is opened. Upon opening, the maximum flow rate set by the controllable feed-rate metering gate is met immediately. Upon closing of the high-speed control gate, no further products enter the sorter.

[0015] In another aspect of the present invention, the product through-put of the sorter is increased by increasing the density of the product at singulation.

[0016] The foregoing and other objectives, features, and advantages of the invention will be more readily understood upon consideration of the following detailed description of the invention, taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE SEVERAL DRAWINGS

[0017] So that the manner in which the described features, advantages and objects of the invention, as well as others which will become apparent, are attained and can be understood in detail, more particular description of the invention briefly summarized above may be had by reference to the embodiments thereof that are illustrated in the drawings, which drawings form a part of this specification. It is to be noted, however, that the appended drawings illustrate only typical preferred embodiments of the invention and are therefore not to be considered limiting of its scope as the invention may admit to other equally effective embodiments.

[0018] In the drawings:

[0019] Figure 1 is a front view of the current sorter type with which the product flow control apparatus may be used.

[0020] Figure 2 is a side view of the current sorter type with which the product flow control apparatus may be used.

[0021] Figure 3 is a side view of the product flow control apparatus with reference to the product reservoir and the sorting machine slide.

[0022] Figure 4 is a front view of the product flow control apparatus with reference to the product reservoir and the sorting machine slide.

[0023] Figure 5 is a front view of typical product to be sorted.

[0024] Figure 6 is view of passing product in full singulation at less than full slide fill.

[0025] Figure 7 is view of passing product in full singulation and at full slide fill.

DETAILED DESCRIPTION OF THE INVENTION

[0026] Referring to the FIGS. 1 and 2, a multi-channel, high-speed sorter for separating nonstandard products from a passing stream or flow of such products is shown. This type of sorting machine is well-known. The invention disclosed herein may be used with any sorter and should not be construed as limited to the particular type of gravity-fed sorter depicted in FIGS. 1 and 2.

[0027] Generally, a typical sorting machine **10** includes one or more slides or slides **12** at a steep angle, usually over 45 degrees from the horizon and preferably nearly vertical on the order of 80 degrees. The slides are held in position by a framework **14**. A hopper **16** containing products **100** (not shown in FIGS. 1 and 2) to be sorted is attached to the same framework and provides products **100** by respective feed delivery control **18** to the slide **12**. The products **100** to be separated or sorted are any food or fungible material, and particularly those that are relatively small, such as almonds, peanuts, and rice grains. The size of the products **100** is product-dependant. In operation, product flow rate is less than free fall due to friction between product and slide surface. As a result product flow rate is quite high, as is well-known in the art. Machines having only a single slide and machines with many more than two slides are not uncommon. For separation or sorting the machine **10** contains at least one product viewer **20**, which may be an optical sensor, to scan passing products **100**. The plane at which the product viewer **20** images the passing products **100** is typically referred to as the scan line **201**. When a product **100** to be separated from the passing flow is identified from the output of a product viewer **20**, the corresponding nozzle of an ejector **36** is engaged,

deflecting the selected product from the product direction of travel **37**.

[0028] Referring to FIGS. 3 and 4, the product flow control apparatus **40** for use in a gravity-fed slide sorter **10** for sorting of products **100** is depicted. Like the prior art, the apparatus includes a product viewer **20** for sorting products **100** based on comparison of pre-determined criteria to output from the product viewer **20**. The gravity slide sorter **10** has at least one inclined chute or slide **12**. In operation it would not be uncommon to have six or more slides per sorter. Positioned adjacent to each slide **12** is at least one product viewer **20** for imaging of passing products **100**, typically below the slide bottom edge **125**. The inclined slide **12** also has a slide upper end **121**, width **122**, and length **124**. It is well known in the art that regardless of the feeder used to supply the products **100** for sorting, the slide length **124** must be sufficient to obtain singulation of the products **100** before the products **100** reach the scan line **201** of the product viewer **20**. Singulation is the condition at which the flow of products **100** becomes laminar, i.e., when all products are moving with the same velocity (speed and direction). Products **100** are therefore not significantly bouncing about but instead cross the scan line **201**, typically after passing the inclined slide bottom edge **125**, on a path parallel to the slide **12**.

[0029] As depicted in FIG. 5, each of the products **100** has a cross-sectional area **101** in the plane perpendicular to the flow valve **150** and a thickness **102**. The operating cross sectional area **123** of the inclined slide **12** is thereby defined by the product of the inclined slide width **122** and the product thickness **102**, as measured perpendicular to the inclined slide **12**.

[0030] Returning to FIGS. 3 and 4, in the preferred embodiment, the product flow control apparatus **40** includes a product reservoir **130**, a flow-rate control passage **140**, a flow valve **150**, and a flow restrictor **160**. The product reservoir **130** contains the products **100** to be sorted. In operation, the product reservoir **130** may be a hopper **16** or even piping directly from a large container of products **100**.

[0031] A flow-rate control passage **140**, which is vertically disposed, communicates with the product reservoir **130**, so that the products **100** stored in the product reservoir **130** descend under gravity to the flow-rate control passage **140**. Similarly, the flow-rate control passage **140** communicates with the inclined slide **12**, so that the products **100** passing through the flow rate control passage **140** descend under gravity to the inclined slide **12**. The flow control **140** has an upper orifice **141**, a lower orifice **142**, a first side **143**, and a cross-

sectional area **144**. The upper orifice **141** provides the point of communication between the product reservoir **130** and the flow-rate control passage **140**, while the lower orifice **142** provides the point of communication between the flow-rate control passage **140** and the slide **12**.

[0032] A flow valve **150** is located intermediate the product reservoir **130** and the flow-rate control passage **140** and operates to preclude or permit the flow of products **100** to the flow-rate control passage **140** among a first flow-valve position **151**, which may be a closed position, and a second flow-valve position **152**, which may be an open position. The flow valve **150** terminates communication between the product reservoir **130** and the flow-rate control passage **140** in the first flow-valve position **151**, thereby precluding the flow of products **100** to the flow-rate control passage **140**. The flow valve **150** permits communication between the product reservoir **130** and the flow-rate control passage **140** in the second flow-valve position **152**, thereby permitting the flow of products **100** to the flow-rate control passage **140**. The flow valve **150** nearly instantaneously positions between the first flow-valve position **151** and the second flow-valve position **152**. Near instantaneous positioning so rapidly permits the flow of products **100** to the flow-rate control passage **140** that the maximum flow rate of products **100** from the product reservoir **130** is essentially immediately attained. Near immediate reaching of the maximum product flow rate from the product reservoir **130** is beneficial as it ensures a complete and usable sort of products at the inception of the sorting operation. This provides a complete set of targets for sorting and full throughput at start-up. Likewise, near instantaneous repositioning so rapidly precludes the flow of products **100** to the flow-rate control passage **140** that the flow rate of products **100** from the product reservoir **130** essentially immediately drops to zero. Near immediate preclusion of product flow from the product reservoir **130** is beneficial as it ensures a complete and usable sort of products throughout the flow of product **100**. This provides a complete set of targets for sorting and full throughput throughout the flow of the product **100**, increasing the percentage of unacceptable product being ejected from the material flow. Passing product **100** moves at full velocity and is singulated throughout the sort. There is, therefore, no "dribble effect" and, as a result, the sorted product **100** does not contain unsorted product **100**. In the preferred embodiment, the flow valve **150** operates between positions precluding or permitting flow in less than one second. The flow valve **150** may be positioned by an actuator **153**. The flow valve **150** may be any type of valve capable of rapid

closure and rapid opening.

[0033] A flow restrictor **160** is located within or adjacent to a flow-rate control passage **140** and operable by an actuator **170** from at least one flow-restrictor position **161**, which includes a first flow-rate-control position **162**. In the preferred embodiment, the flow restrictor **160** is affixed within the flow-rate control passage **140** at the flow-rate control passage first side **143**. The flow restrictor **160** reduces the cross-sectional area **144** of the flow-rate control passage **140** at the first flow-rate-control position **162**. The cross-sectional area **144** of the flow-rate control passage **140** when the flow restrictor **160** is in the first flow-rate-control position **162** is comparable to, i.e. nearly equal but not exceeding, the operating cross sectional area **123** of the inclined slide **12**.

[0034] As a result, the maximum flow rate of products **100** exiting the flow-rate control passage **140** is or approaches the maximum flow rate at which the products **100** may descend the slide **12** and reach singulation at or before the scan line **201**. Thus, the products **100** are at or near maximum density for slide **12**, unlike present sorting machines. This encourages sorting at maximum capacity as the product **100** is introduced to the slide **12** at the flow rate necessary to obtain full slide fill, as depicted in FIG. 6, while eliminating potential incomplete sorting targets at sort inception and termination. As the flow restrictor **160** is not adjusted to preclude flow of the products **100** at the end of operation, the flow restrictor **160** presents a downwardly-inclined face **163** to the products **100** at all times. Cessation of product being introduced to the slide **12,** or shutdown of the sorting system, therefore cannot result in product **100** being stranded intermediate the product reservoir **130** and the slide **12**, and thereby avoids the need to expel unprocessed material.

[0035] The combination of these devices thereby overcomes the shortcomings of the art, while permitting the maximum flow rate possible for sorting. In operation, the throughput of a sorting machine coupled to this product flow control apparatus 40 is substantially increased. In testing of wheat, the throughput of a sorting machine has been doubled. In other products, the throughput of the machine has been tripled. As a result the power requirements associated with the sorting operation are reduced. Similarly the space requirements associated with the sorting operation are reduced as a result of use of the present invention.

[0036] The terms and expressions which have been employed in the foregoing specification are used therein as terms of description and not of limitation, and there is no

intention, in the use of such terms and expressions, of excluding equivalents of the features shown and described or portions thereof.

CLAIMS

I claim:

1. A feed control apparatus (40) for use in a gravity slide sorter (10) for sorting of products (100);

each of said products (100) having thickness (102);

said gravity slide sorter (10) having a product viewer (20), said product viewer (20) defining a scan line (201);

said gravity slide sorter (10) sorting products (100) based on comparison of pre-determined criteria to output from said product viewer (20);

said gravity slide sorter (10) having at least one inclined slide (12);

said inclined slide (12) having a slide upper end (121);

said inclined slide (12) having width (122);

said product viewer (20) positioned adjacent said at least one inclined slide (12);

said included slide (12) having an operating cross sectional area (123), said operating cross sectional area (123) being the product of said inclined slide width (122) and said product thickness (102);

said inclined slide (12) having a length (124) and incline sufficient to obtain singulation of said products (100) before said products (100) reach said scan line (201);

comprising:

a product reservoir (130);

said product reservoir (130) containing said products (100) to be sorted;

a flow-rate control passage (140);

said flow-rate control passage (140) having an upper orifice (141), a lower orifice (142), a first side (143), and a cross-sectional area (144);

said flow-rate control passage upper orifice (141) being in communication with said product reservoir (130);

said flow-rate control passage lower orifice (142) being in communication with said at least one inclined slide (12);

said flow-rate control passage (140) being vertically disposed;

a flow valve (150);

said flow valve (150) intermediate said product reservoir (130) and said flow-rate control passage (140);

said flow valve (150) operable among a first flow-valve position (151) and a second flow-valve position (152);

said flow valve (150) terminating communication between said product reservoir (130) and said flow-rate control passage (140) in said first flow-valve position (151);

said flow valve (150) permitting communication between said product reservoir (130) and said flow-rate control passage (140) in said second flow-valve position (152);

said flow valve (150) near-instantaneously repositioned between a first flow-valve position (151) and a second flow-valve position (152);

a flow restrictor (160);

said flow restrictor (160) operable among at least one flow-restrictor position (161),

said at least one flow-restrictor position (161) including a first flow-rate-control position (162);

said flow-restrictor (160) reducing said cross-sectional area (144) of said flow-rate control passage (140) at said first flow-rate-control position (161);

said cross-sectional area (144) of said flow-rate control passage (140) at said first flow-rate-control position (161) comparable to said operating cross sectional area (123) of said inclined slide (12);

said flow restrictor (160) presenting a downwardly-inclined face (163) to said products (100) at all times.

2. The feed control apparatus (40) of claim 1 further comprising:

a flow-restrictor actuator (170), said flow-rate control actuator (170) positioning said flow restrictor (160).

3. A feed control apparatus (40) for use with a gravity slide sorter (10) for sorting of products (100), each of said products (102) having thickness;

comprising:

a product supply (130);

a vertically disposed flow-rate control passage (140) in communication with said product supply (130) and in communication with said gravity slide sorter (10), said flow-rate control passage (140) having a first side (143) and an internal cross-sectional area (144);

a flow valve (150) intermediate said product supply (130) and said flow-rate control passage (140), said flow valve (150) near-instantaneously repositionable among a closed flow-valve position (151) and an open flow-valve position (152);

a flow restrictor (160) positioned in said flow-rate control passage (140) and operable among a plurality of flow-restrictor positions to alter said cross-sectional area (144) of said flow-rate control passage (140) at said first flow-rate-control position (151).

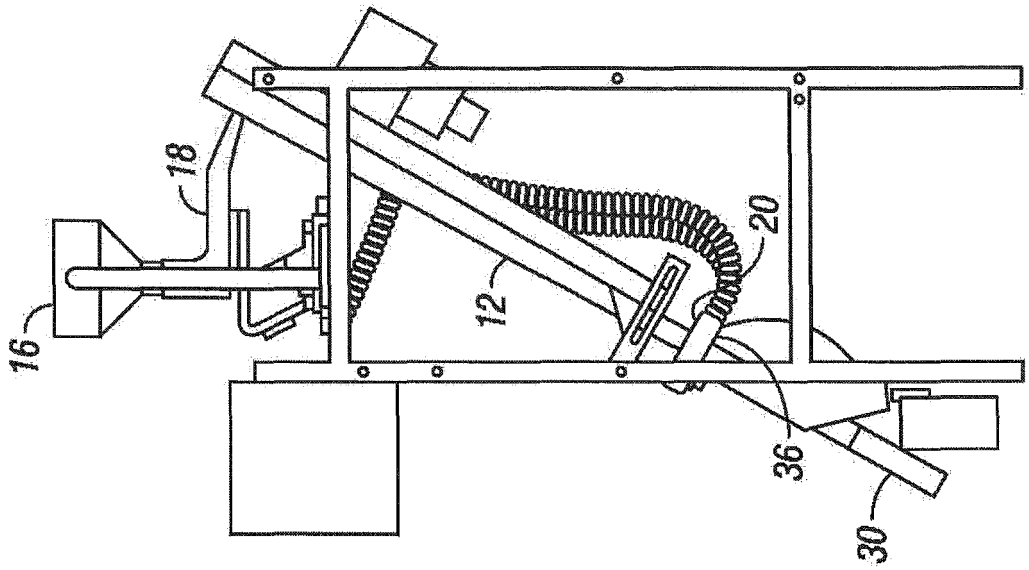


FIG. 2
(Prior Art)

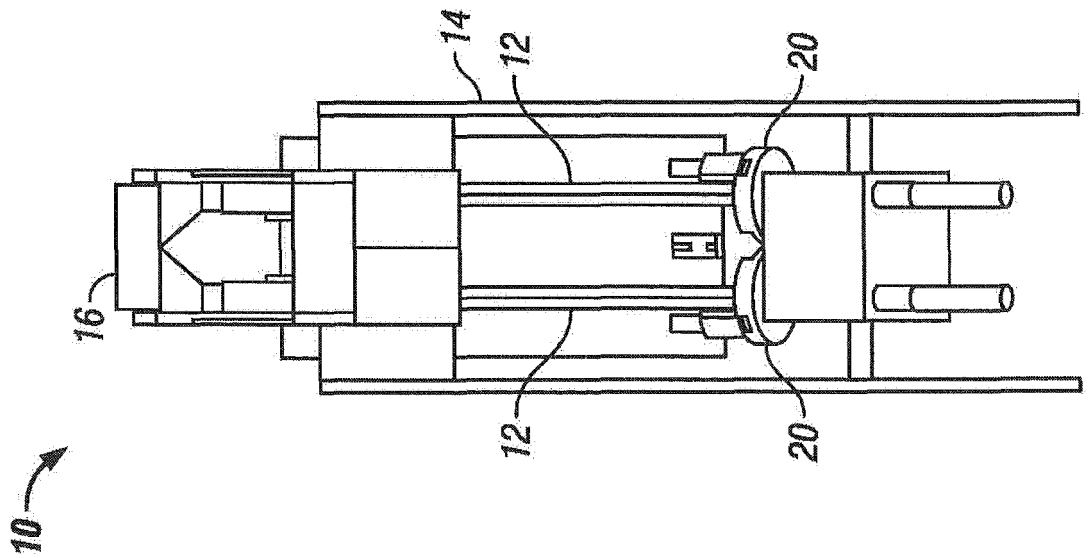


FIG. 1
(Prior Art)

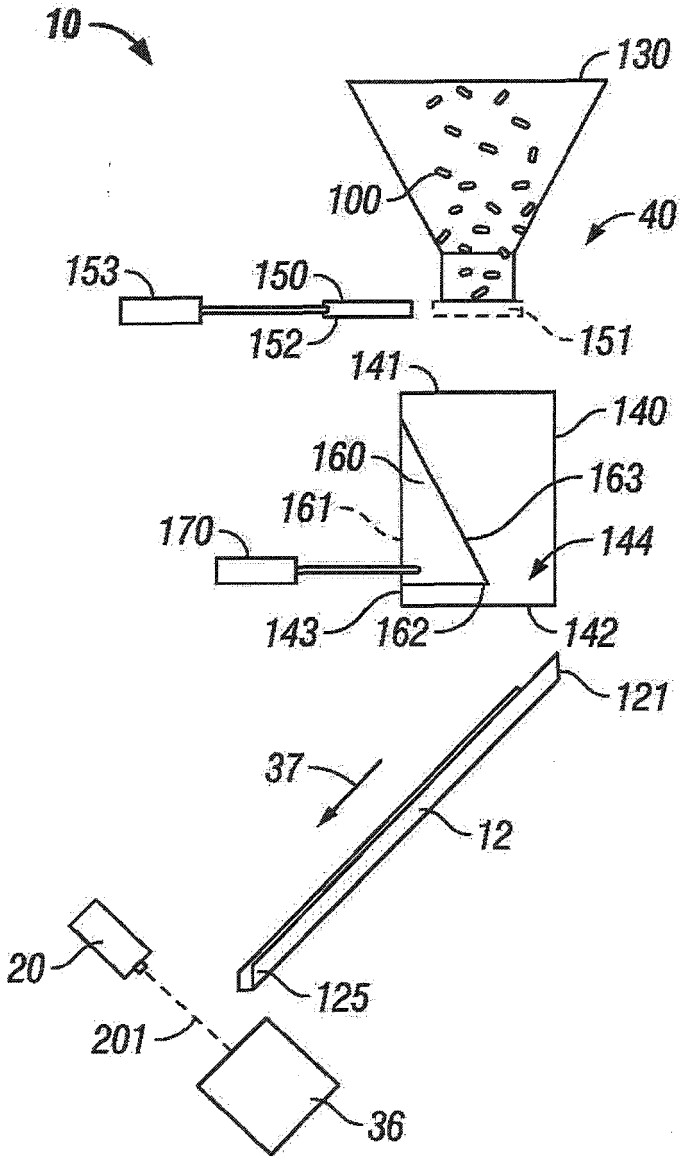


FIG. 3

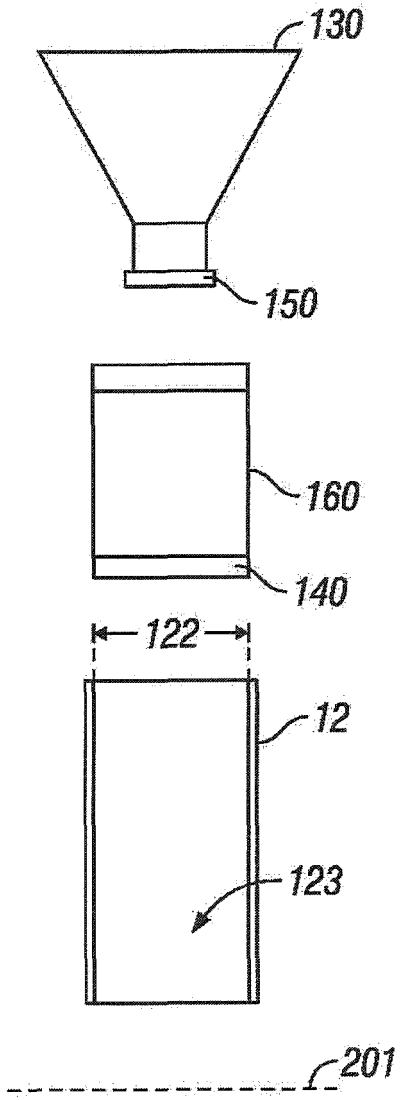


FIG. 4

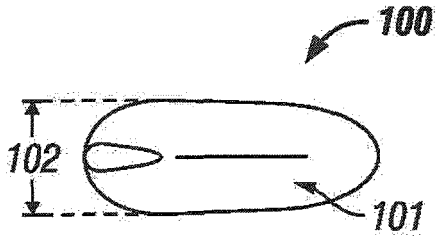


FIG. 5

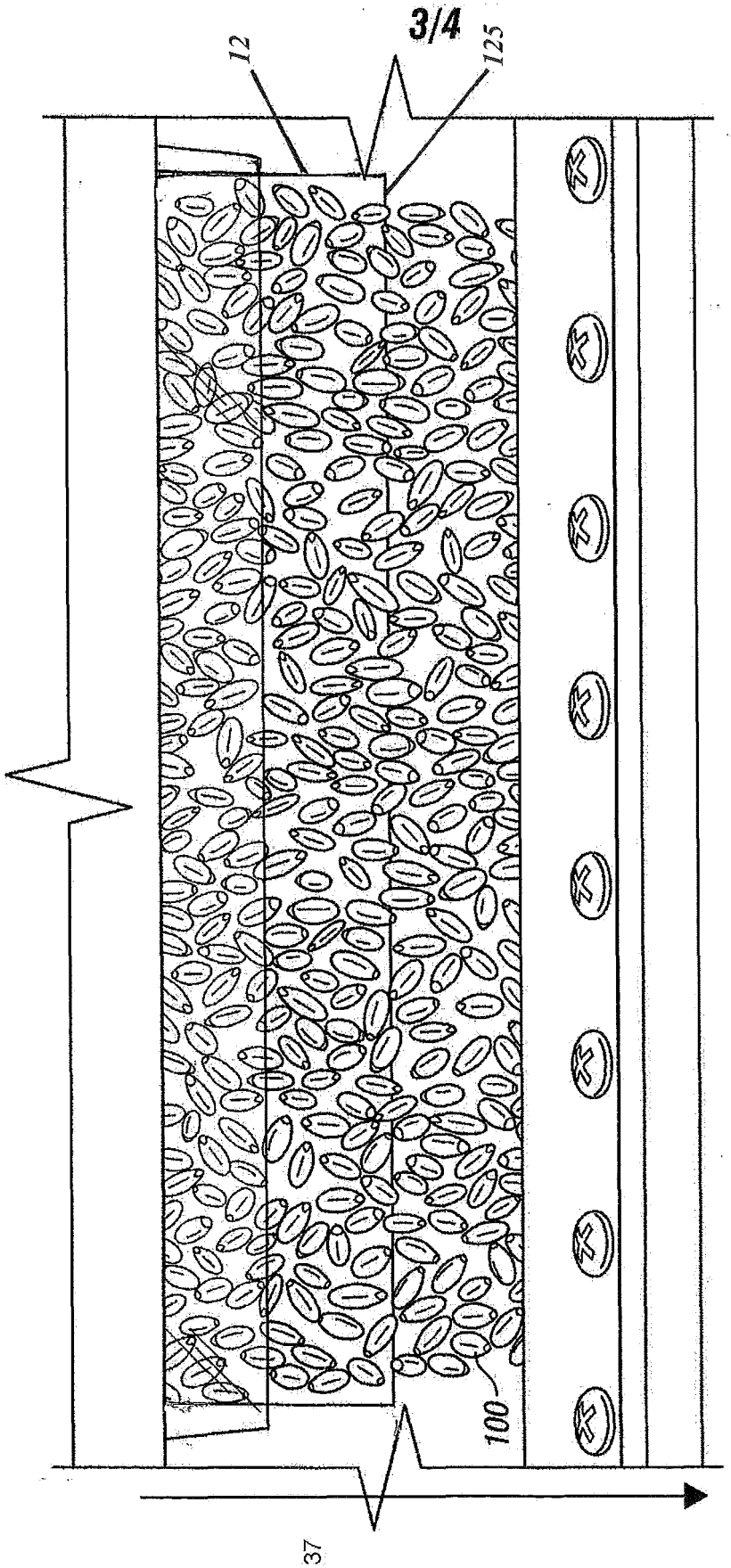


FIG. 6

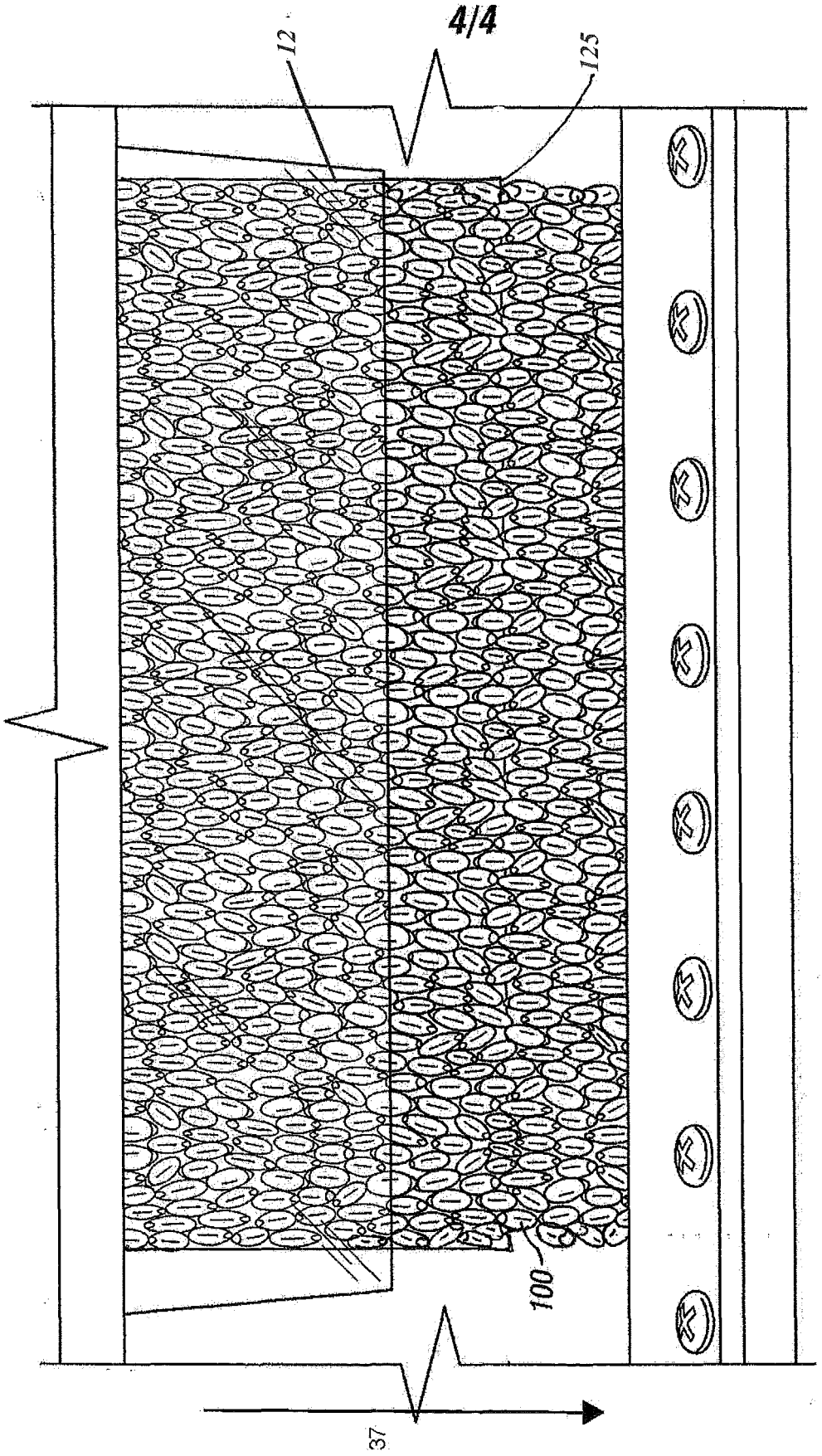


FIG. 7

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US 08/54062

A. CLASSIFICATION OF SUBJECT MATTER
IPC(8) - B07C 5/00 (2008.04)
USPC - 209/509
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
USPC: 209/509

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
USPC: 209/233, 509, 546, 552, 606

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
PubWEST, Google Scholar. Search Terms: Flow, rate, control, singulation, product, sort, slide, incline, scan, valve, 'product reservoir', 'gravity slide sorter', view, 'gravity slide', container, dispenser, reservoir, slope, 'feed control',

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	*US 5,740,091 A (LAZZAROTTI, ET AL) 21 April, 1998 (21.04.1998). Column 1, lines 51-54;* column 4, lines 10-14 and 14-24; column 6, lines 13-15, 50-55 and 61-column 7, line 13; column 12, lines 50-67; figures 1, 3-7, 11, 15.	1-3
A	US 4,410,091 A (COWLIN, ET AL) 18 October 1983 (18.10.1983), entire doc	1-3
A	US 2006/0025884 A1 (HENKEL) 2 February 2006 (02.02.2006), entire doc	1-3

☐ Further documents are listed in the continuation of Box C. ☐

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Date of the actual completion of the international search	Date of mailing of the international search report
7 July 2008 (07.07.2008)	14 JUL 2008
Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-3201	Authorized officer: Lee W. Young PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774

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