Title: APPARATUS AND METHOD FOR PORTION CUTTING OF FOOD ARTICLES

Abstract: The present invention relates to an apparatus and a method for portion cutting of items, in particular food articles, comprising scanning means (6) comprising an ultrasonic and/or X-ray sensor for registration of selected item parameters such as contour and inner composition; control means for the determination of a cutting pattern based on said selected item parameters and predetermined portion cutting parameters; at least a trimming unit for trimming the items in a direction substantially along the conveying direction and/or a portion cutting unit for sectioning of the items; and conveyor means for conveying the items to the scanning means and the portion cutting means; wherein said conveyor means and said trimming and/or portion cutting units are controllable by the control means according to said cutting pattern.
APPARATUS AND METHOD FOR PORTION CUTTING OF FOOD ARTICLES

The present invention relates to an apparatus and a method for portion cutting of food articles.

From Danish utility model no. DK 96 00164 U3 such an apparatus for portion cutting of food product items is known. Herein, a machine for portion cutting of food product items is described, which comprises a rotatable cutting unit for sectioning the items, which are guided through the cutting unit by a first and second conveyor respectively. A vision system for detecting the surface geometry of the items is arranged at the first conveyor. The form of the items is registered in a control system controlling the machine for cutting the items into portions of a predetermined length or size.

The items are guided on a conveyor and scanned in a vision system. Based on this registered item form and/or average density, and the conveyor velocity, the cutting rate of the cutting unit is controlled in order to make the portions or slices uniform or in a predetermined individual size, as long as no relative movement between the products and the conveyor occurs between the vision system and the cutting unit. This relative movement may be avoided by applying holding means during use of the cutting unit.

Conventionally, the average density is known by the control system from either (a) manual input or (b) weighings performed in connection with the process and so the above-mentioned term “size” may include the weight of the items.

In connection with certain product types, the items have non-uniform consistence. This may e.g. be caused by meat pieces containing larger or smaller amounts of fat, bone, skin or the like, and also varying inner distribution of fat in the meat part, i.e. varying degree of marbling, over the section of the items. Because of this non-uniform consistence the density varies and so the approximation being made, that the
items are uniform in density, causes in these cases that the cut pieces are weighing different from their predicted weight.

Furthermore, the cutting process may be subject to a risk of disturbance or even interruption, if the knife of the cutting unit is not able to cut through a section of the item containing bone. In other cases it can happen that the items are pushed during the cutting, in which cases a non-precise cutting may result from this.

In US patent 6,129,625 is described an apparatus and a method of trimming a meat article by using a trimming blade to cut away e.g. a brim of fat based on ultrasonic measurement and predetermined trim parameters. The brim of fat is positioned facing downwards as the trimming blade is positioned opposing a holding device comprising a number of idler wheels aside from the conventional driving rolls, which entails a complex construction in order to keep down the piece of meat during trimming of the fat layer.

In European patent EP 0 324 522 is described a device for trimming a bacon and/or fat layer from meat, in which the device comprises knife sections for adjustable trimming of a varying thickness of fat layer based on ultrasonic measurement of the fat layer and a gripping roll over which the downwards facing fat layer is guided during trimming.

In US patent application 2002/0067797 X-ray analysis is performed on a meat article in order to cut a meat piece containing a lower or higher density element and having a selected special shape to ease the off-loading from a conveyor.

None of the above prior art considers portion cutting into relatively uniformly sized meat pieces of similar appearance.

On this background, it is the object of the present invention to provide an apparatus and a method of portion cutting having increased reliability and dependability.
This object is achieved by an apparatus for portion cutting of items, in particular food articles, comprising:

- scanning means comprising an ultrasonic and/or X-ray sensor for registration of selected item parameters such as contour and inner composition;
- control means for the determination of a cutting pattern based on said selected item parameters and predetermined portion cutting parameters;
- at least a portion cutting unit for sectioning of the items and/or a trimming unit for trimming the items in a direction substantially along the conveying direction, said portion cutting and trimming units being controllable by the control means according to said cutting pattern; and
- conveyor means for conveying the items to the scanning means and the portion cutting means, said conveyor means being controllable by the control means according to said cutting pattern.

By using X-ray and/or ultrasonic scanning the apparatus according to the invention will be able to determine the composition of the items and not just the outer form of the items. Hereby, the consistence and the inner texture may be determined with fine accuracy, such that areas of fat and/or bone may be identified and the cutting and/or trimming may be performed based on this determination. The cutting is thus regulated or controlled in accordance to said determination, based on the portion cutting characteristics or parameters, provided by user selection of the final portion cut sizes and product type and said item parameters, provided by the scanning means such as item composition, i.e. marbling, bone and/or fat and/or skin content, and item form, including surface contour. The control means is adjusting the rate of the cutting unit and the conveying speed of the items to the cutting unit in accordance with predetermined portion cutting criteria established as portion cutting parameters, such as e.g. the weight of the portion cut pieces being similar, or being different in a controlled way, or the portion cut pieces being without bone or without a fat brim etc. Hereby, the items can be divided into pieces in such a way as to each of the portion cut pieces being sold to a better price as compared to the quality of meat.
product type, the portion cut pieces have been cut from. Further, the waste percentage provided by an apparatus according to the invention may be substantially reduced, as the resulting portion cut pieces has been divided into uniform or predetermined portions with a high degree of accuracy.

By the invention it has been realized, that a scanning performed with an X-ray and/or ultrasonic scanning device may be utilised for the determination of the surface geometry and marbling of the items in question.

A meat article may thus be trimmed based on the available determined cutting pattern; avoiding a need for further scanning means or control means for the trimming action. The cutting pattern may thus be calculated to provide for both portion cutting and trimming action. Thus, product types such as ham, bacon, i.e. comprising a brim of fat or layer of bone may also be trimmed in order to provide portion cut meat pieces, which may be sold to a better price as compared to the quality of meat product type, the portion cut pieces have been cut from. Further, a high degree of accuracy is obtained for the cutting profile for the trimming of the meat product in order to completely remove the fat layer or alternatively to leave a controlled amount of fat from the fat layer in order to improve the taste of the portion cut meat piece, when being prepared by the consumer by roasting or frying. A further advantage of a trimming unit being provided is the possibility of utilising said trimming unit for cutting an item into a lower and an upper trim part, both being further processed, e.g. by packing, or alternatively one or both trim parts being destined for removal. The items may also be cut into portions for subsequent manual or automatic trimming and/or quality sorting. In that case the portion cutting may be arranged so that the items after trimming have the predetermined size, e.g. the same size.

In the preferred embodiment, the trimming unit of the apparatus comprises a cutting device comprising at least one section, each section being individually adjustable in height, i.e. distance to a surface of the conveyor, in accordance with said cutting
pattern. The cutting pattern available for the portion cutting and trimming is thus further utilised for a trimming being adjustable in resulting thickness of the trimmed fat layer, and consequently allows for a very accurate trimming of a fat layer of varying thickness in a direction perpendicular to the conveyor direction. Thus, the resulting waste percentage may be kept even lower, and the resulting portion cut meat pieces may be of a much higher quality, that the initial product type initially gave rise to. In one embodiment said at least one section includes a cutting member, such as a wire, saw, or knife. In one embodiment the cutting member includes a cutting edge, which may be provided with means for providing a reciprocating movement. Thus, the trimming unit may adjustably be utilised for a very precise trimming action.

In one embodiment a holding device is provided at the conveyor for retaining the items during trimming and/or cutting. In the preferred embodiment, the holding device is a vacuum box. Said vacuum box is advantageous for retaining the item during trimming, since the vacuum ensures that the item is stationary relative to the conveyor surface and does not move during trimming, does not deform during retaining and does not form a hinder for an adjustable trimming of a fat layer with varying thickness transversal to the conveyor direction. Accordingly, this embodiment eases the trimming operation and a further more accurate removal of fat or low quality meat. The layer to be trimmed may be oriented in any convenient direction.

As an alternative to the vacuum box, a pick-up freeze drum may be used. According to this embodiment, the food item is brought into contact with the freezing drum surface rotating with a speed substantially the same as the conveyor velocity. The item sticks to the drum surface due to the freezing surface temperature. The item is then lifted up from the conveyor as it is rotated by the conveyor and is then trimmed at a subsequent trimming unit located at the periphery of the drum. The trimmed item is then returned to a conveyor for portion cutting. The drum may also be provided
with ultrasonic measurement equipment for scanning the food item when it is held in contact with the drum surface, and the trimming may be adjusted accordingly.

In one embodiment, weighing means are arranged upstream the scanning means for weighing the items before scanning. Preferably, these weighing means may be a flow weighing device inserted in those conveyors guiding the items into the scanning process. Thus, a further weight parameter may be added to the portion cutting parameters obtained from user input and the scanning of the item parameters in order to obtain a high level of accuracy in trimming and cutting according to the determined cutting pattern.

By the scanning sections of the items are determined as they are guided through the scanning plane. In the control unit the three-dimensional structure of an item is established, and based upon this, the cutting process of each individual item is planned. The scanning means may have a number of X-ray sources and sensors arranged to look at the items from various angles.

Further, the invention provides for a method for portion cutting of items, in particular food articles, with an apparatus according to the invention, said method comprising

- providing portion cutting parameters such as article type or size to a control means;
- conveying the items through scanning means, and the trimming unit for trimming the item, and/or the portion cutting unit for sectioning the item;
- scanning the items with an ultrasonic and/or X-ray sensor for registration in the control means of selected item parameters;
- determining a cutting pattern based on said registered item parameters and portion cutting parameters; and
- controlling the conveyor and the trimming unit and/or the portion cutting unit for a sectioning of the items according to said cutting pattern.

According to the invention, said method avails the possibility to further improve the portion cutting of the items and thus a more economical portion cutting of the items is achieved, as the items are cut into different meat qualities and waste is reduced.
In one preferred embodiment, the method comprises that after the scanning the items are trimmed during conveying according to said cutting pattern. Thus, an improved and more accurate trimming of the items and thus resulting portion cutting may be achieved.

In the following, the invention is described in more detail with reference to the accompanying drawings, in which:

10 Fig. 1 is a schematic perspective view of an apparatus according to the invention;

Fig. 2 is a schematic perspective view of an apparatus according to a second preferred embodiment of the invention;

Fig. 3 is a schematic view of the control means by an apparatus according to the invention;

Fig. 4 is a side view of a detail of the apparatus of Fig. 3;

Fig. 5 is a front view of a first embodiment of the detail of the apparatus of Fig. 3;

Fig. 6 is a front view of a second embodiment of the detail of the apparatus of Fig. 3 in an inactive position; and

Fig. 7 is a front view of the same second embodiment of the detail of the apparatus of Fig. 3 in an active position.

As seen from Fig. 1, the apparatus for portion cutting according to a preferred embodiment of the invention comprises three conveyors 3, 4, 5, arranged in line in a frame (not shown). Between the two conveyors 3, 4 is arranged a scanning unit 6, capable of scanning the items 1 and detect the form of the items in the entire scanning plane, i.e. 360° around the axis of the conveyor direction. Between the second and third conveyor 4, 5 is arranged a portion cutting unit 2, comprising a rotatable knife 10, driven by a motor 12 in the plane substantially perpendicular to
the conveying direction, and in the embodiment shown in Fig. 3 also a trimming unit 8, as described below.

At the end of the second conveyor 4, immediately at the trimming unit 8 and/or at the portion cutting unit 2, a holding device 7 such as a belt conveyor or an arm may be provided in order to hold down the items 1 during trimming and/or cutting to prevent these from moving during cutting and/or trimming. Further, at this position, upstream the cutting unit 2 as shown in fig. 3 or alternatively downstream (not shown) the cutting unit 2, the trimming unit 8 may be provided, preferably in connection with a holding device 9 such as a vacuum box. Said trimming unit 8 advantageously trims the items 1 in a direction parallel to the conveying direction, and will be described further below.

Alternatively a 180° scanning device may be used as shown in Fig. 2. Thus, the items may be guided through the scanning and to the cutting and optional trimming on the same conveyor.

The conveyors may be a combination of any conventional conveyor type, including a V-belt type conveyor as described in the patent application WO 04/034794 assigned to applicant.

During scanning the form and composition of the items 1 is recorded by performing a scan using ultrasound (not shown) and/or X-rays (see fig. 1), optionally combined with a surface geometry scan (see fig. 2), e.g. performed by a vision system or a colour scanning system. This scanning of the items combined with a registration of the conveyor movement forms the basis for a form and structural analysis of the items, said analysis being performed in a control system 21. By the control system, the conveyor movement, cutting of the cutting unit, and trimming of the optional trimming unit is being controlled in order for the portion cutting to be performed according to a predetermined design or resulting determined cutting pattern. This design is modified based on the scanning, as the control system is adapted to
establish the optimal cutting pattern of a given item based on the form and structure determination thereof.

As shown in Fig. 3 a weighing device 20 is optionally arranged upstream the first conveyor 3, whereby the weight of the individual items 1 is determined before scanning. The control system 21 is provided with the scanned or otherwise measured item characteristics or parameters, such as density and total weight, but may also be provided with portion cutting characteristics or parameters, such as type of article, portion size, etc, e.g. by user input on an interface 23 or preselected item parameters provided to the control unit in a conventional way. Based upon this information the cutting pattern is calculated by the control system based upon user input from a user interface 23 of the control system.

Preferably, the portion cutting unit 2 comprises a rotatable knife, as shown in Fig. 1, but it has by the invention been realised, that different kinds of partition means by cutting or sawing (belt saw, circular saw, etc.) may be utilised, including a falling knife, ultrasound cutting, water or laser cutting, just as knifes of different types may be utilised depending on the particular cutting job, i.e. the type of article to be portion cut and the intended portion cut. Alternatively, the item does not have to be cut all the way through, but may be marked by a part cut, a surface cutting marker or the like.

Preferably, the trimming unit 8 comprises a lateral trimming device with a cutting member comprising one section as seen in Fig. 5 or a lateral section strip cutting device comprising multiple sections as seen in Fig. 6 and 7.

As seen in Fig. 5, the lateral trimming device may comprise a knife or saw or wire 81 provided in such a way as to cut in a direction substantially parallel to the conveying direction as shown in Fig 5. In Fig. 5 the cutting member 81 is shown with a substantially horizontal orientation. However, by the invention it is realized that the cutting member 81 of the trimming device may also be oriented with a substantially
vertical orientation (not shown). In the embodiment of Fig. 5 the trimming device comprises a cutting member 81 comprising a substantially flat knife blade, optionally provided with saw teeth for trimming an upper part 41, e.g. a fat layer, from a remaining lower part 42, here a meat part. The trimming device may comprise means for providing the cutting edge of the cutting member a reciprocating movement, i.e. it may vibrate in order to improve the trimming action, possibly by very small movements approaching ultrasound. Also, the trimming device may comprise a mounting 82 for the cutting member, said mounting being rotatable in such a way that the cutting member may assume different shapes for cutting as indicated by the arrows A and B. As indicated by arrow R, the trimming device may be moved between active and non-active positions.

A holding device 9 may be provided during the trimming action, preferably a vacuum box implemented to function as a retaining device for the item on the conveyor surface during trimming, where the conveyor surface is of a type to accommodate such a vacuum box. Alternatively, the holding device 9 may comprise a holding belt or arm or the like.

A cutting device 2 may be utilised when cutting article types having a marbled meat and fat structure, e.g. beef cuts with marbling, and the trimming device may be idle, as shown in Fig. 6.

The trimming device 8 comprises at least one section, each section being individually adjustable in height, i.e. distance to a surface of the conveyor, in accordance with said cutting pattern. In Fig. 7 is shown a trimming device comprising three sections for trimming a fat layer or the like, resulting in an upper trim part 41 comprising three strips and a lower trim part 42 in one piece. In Fig. 7, is indicated the fat layer facing upwards in the drawing, but of course a fat layer or trimmed part may face downwards as well, depending on type of meat product and user selected portion cutting parameters.
The trimming device 8 may be active as seen in Fig. 7 e.g. when cutting article types having bone or fat in a definite layer provided along the conveying direction, e.g. ham or bacon type meat articles or combination meat types comprising both meat, fat and bone.

It has been realised with the invention, that the lateral trimming of the item may result in an upper 41 and a lower trim part 42, where either the lower part or the upper part is a trimmed layer for possible removal, or alternatively, none of the trim parts are trimmed layers, but rather two parts for possible further processing, e.g. for selective packaging of the resulting parts after portion cutting.

Further weighing devices and/or further control devices may be provided downstream the apparatus according to the present invention, said devices comprising signal feedback for automatic adjustment and/or calibration of the machine.

The invention has now been described in relation to a preferred embodiment, but by the invention it has been realised, that other variants and equivalent solutions may be provided without departing from the scope of the invention as described in the accompanying claims.
Patent claims

1. An apparatus for portion cutting of items, in particular food articles, comprising
   - scanning means comprising an ultrasonic and/or X-ray sensor for registration of
   selected item parameters such as contour and inner composition;
   - control means for the determination of a cutting pattern based on said selected item
   parameters and predetermined cutting parameters;
   - at least a trimming unit for trimming the items in a direction substantially along the
   conveying direction and/or a cutting unit for sectioning of the items; and
   - conveyor means for conveying the items to the scanning means and the cutting
   means;
   wherein said conveyor means and said trimming and/or cutting units are controllable
   by the control means according to said cutting pattern.

2. An apparatus according to claim 1, in which the trimming unit comprises a cutting
   device adjustable in height, i.e. distance to a surface of the conveyor, in accordance
   with said cutting pattern.

3. An apparatus according to claim 2, in which the cutting device comprises a
   multiple of sections, each section being individually adjustable.

4. An apparatus according to claim 3, wherein each section includes a cutting
   member, such as a wire, saw, or knife.

5. An apparatus according to claim 4, wherein the cutting member includes a cutting
   edge, which may be provided with means for providing a reciprocating movement.

6. An apparatus according to any of the preceding claims, wherein a holding device
   is provided at the conveyor for retaining the items during trimming and/or cutting.

7. An apparatus according to claim 6, wherein the holding device is a vacuum box.
8. An apparatus according to any of the preceding claims, wherein weighing means are arranged upstream the scanning means for weighing the items before scanning.

9. An apparatus according to any of the preceding claims, wherein the scanning means further comprises a vision system for detecting the surface geometry of the items.

10. A method for portion cutting of items, in particular food articles, with an apparatus according to any of the preceding claims, said method comprising
- providing cutting parameters such as article type or size to a control means;
- conveying the items through scanning means, and the trimming unit for trimming the item, and/or the cutting unit for sectioning the item;
- scanning the items with an ultrasonic and/or X-ray sensor for registration in the control means of selected item parameters;
- determining a cutting pattern based on said registered item parameters and cutting parameters; and
- controlling the conveyor and the trimming unit and/or the cutting unit for a sectioning of the items according to said cutting pattern.
INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 B26D/30 B26D/20

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)
IPC 7 B26D A22C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic database consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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Further documents are listed in the continuation of box C. Patent family members are listed in annex.

*X* Special categories of cited documents:
* "A"* document defining the general state of the art which is not considered to be of particular relevance
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* "S"* document member of the same patent family

Date of the actual completion of the international search
6 August 2004

Name and mailing address of the ISA
European Patent Office, P.O. 5818 Patentlaan 2 NL – 2280 HV Rijswijk
Tel. (+31-70) 340-2040, Tx. ST 651 epo nl, Fax: (+31-70) 340-3016

Date of mailing of the international search report
16/08/2004

Authorized officer
Rabolini, M
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