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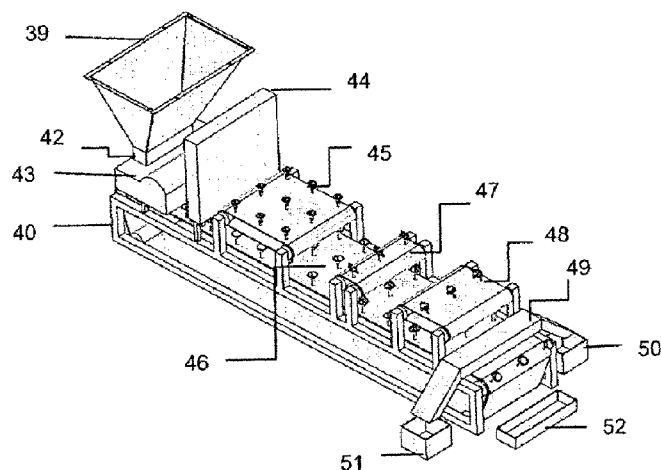


FIG.1

(57) Abstract: The present invention discloses an improved system with customized steam cooking, popping, tearing and shell separator mechanisms for de-shelling cashew nut and an improved process with customized steam cooking, popping, tearing and shell separator mechanisms for de-shelling cashew nut. The improved system comprises of: a main frame, a hopper, a feeding unit, a singulator unit, a main conveyor (horizontal or rotary), an optics unit, a customized steaming system, a customized popping system, a customized tearing system, a shell separator unit, and multiple collection units. The disclosed improved system provides accurate amount of pressurized steam to individual cashew nut according to their steam requirement, thereby enabling such customized steamed cashew nuts for accurate popping and accurate tearing each cashew nuts, thereby ultimately avoiding high cashew kernel breakage and providing high percentage of substantially whole kernel as a final product, moreover this kind of customized steaming adapted for steaming cashew nuts provide good quality of kernels which has high market value.



AN IMPROVED SYSTEM FOR DE-SHELLING CASHEW NUT AND A
PROCESS THEREOF

FIELD OF THE INVENTION

[0001] The present invention relates generally, to a cashew nut de-shelling machines or systems and processes for de-shelling nut, and more particularly, it relates to an improved system with customized steam cooking, popping, tearing and shell separator mechanisms for de-shelling cashew nut and the invention also relates to an improved process with customized steam cooking, popping, tearing and shell separator mechanisms for de-shelling cashew nut.

BACKGROUND OF THE INVENTION

[0002] The most critical and important step is cashew nut de-shelling upon which the quality of cashew nut is dependent as whole kernel is considered as commercially valuable property of cashew nut. Therefore, many inventions are developed to provide whole kernel from the cashew nut shell. Few patents like GB 727798 and US2806501 perform de-shelling operations by maintaining steaming pressure or temperature, though steaming pressure or temperature is pre-determined, it can cause damage to the inner whole kernel by ejection as there is lack of accurate measuring of temperature or pressure required to steam the cashew nut based on individual analysis which does not guarantee the ejection of whole kernels, therefore being less efficient. With advancements in technologies, de-shelling of hard nuts has been progressed for providing automatic and mechanical nut de-shelling machines having cutting blades for performing de-shelling operation. Accordingly, Chinese Pub. No. CN104643257 titled "Full automatic cashew hull breaking machine", US 3774526 titled "Nut shelling machine", US 4321865 titled "Apparatus for treating nuts or the like",

these three inventions have major disadvantage of uncontrolled cutting of shell with blades resulting in significantly damaged inner kernel and lack of automatic separation of kernel from shell which decreases the machine efficiency. US 4793248 titled “Nut shelling machine”, discloses a de-shelling machine, wherein initially the cashew nuts are graded based on sizes and based on type of group, the machine uses different discs that are used to create an impact force on the cashew nut to break open the cashew to separate kernel from the shell. The machine has major disadvantage of not analyzing any cashew individually for a proper impact, thereby making the machine less efficient. WIPO Pub. No. WO 2015059720 titled “An automatic cashew nut de-shelling machine” discloses the machine which comprises of units with pulleys and blades that carry the oriented cashew to the de-shelling operation, where there are two adjustable blades that shear open the cashew at its dehiscence. The major disadvantage of the machine is even if the machine comprises of sensing wheel for de-shelling, the machine lacks any proper sensing or monitoring mechanism or system which accurately determines the depth of cut on cashew nut in real time, thereby making the machine less efficient due to this uncontrolled de-shelling mechanism without maintaining high rate of undamaged and whole kernels while de-shelling.

[0003] As per our findings, the significant drawbacks of most of the existing de-shelling technologies is un-controlled steaming process, neglecting of variations in steaming requirement of each cashew nut while steaming cashew nut, lack of monitoring and controlling of cutting blade’s activities while de-shelling resulting in production of undesirable broken kernels. Further, in addition to these disadvantages, there is also lack of any efficient automatic shell separator mechanism which separates cashew nut shells and

kernels after de-shelling automatically to eradicate labor dependence which is high cost affair.

[0004] Therefore, it would be highly desirable to provide an improved system for de-shelling cashew nut and an improved process for de-shelling cashew nut, thereby obviating all abovementioned disadvantages of the existing cashew nut de-shelling technologies.

SUMMARY OF THE INVENTION

[0005] Present invention recognizes and addresses various disadvantages and drawbacks of the existing cashew nut de-shelling machines/systems and cashew nut de-shelling processes to provide an improved system with customized steam cooking, popping, tearing and shell separator mechanisms for de-shelling cashew nut which de-shells cashew nut after controlled steaming of individual cashew nut. The present invention also provides an improved process with customized steam cooking, popping, tearing and shell separator mechanisms for de-shelling cashew nut to produce commercially valuable high quality whole cashew kernels in more accurate manner. The improved system for de-shelling cashew nut provides customized/ controlled steaming of individual cashew nut based on different external and internal characteristics of individual cashew nut before it goes for popping, tearing and shell separation by avoiding extra softening of cashew nuts to significantly enable the improved system to accomplish accurate popping and accurate tearing of each cashew nut which ultimately provides higher percentage of whole kernels as the final product. Further the improved system also provides a shell separator mechanism to separate cashew kernels from cashew shells, thereby decreasing labor intensity. The present invention also discloses the constructional/structural variations of the improved process with customized steam cooking, popping, tearing and shell separator mechanisms for de-shelling cashew nut. The

constructional/structural variations of the improved system shares in common essentially all parts/features or mechanisms of the present invention and all these parts of the improved system are arranged in exactly the same sequence viz. a main frame for supporting all parts located on or around the main frame, a hopper, a feeding unit, a singulator unit, a main conveyor (horizontal or rotary), an optics unit, a customized steaming system, a customized popping system, a customized tearing system, a shell separator unit, and multiple collection units. Moreover, said essentially all parts/features or mechanisms of the improved system functions essentially in the same manner to accomplish the desired result/same end product (properly de-shelled and separated cashew nut kernel from cashew nut shell) for the purposes of carrying out the same said improved process with customized steam cooking, popping, tearing and shell separator mechanisms for de-shelling cashew nut. The constructional variation in the improved system lies only in structural arrangement of the main conveyor which is horizontal conveyor in one structural arrangement of the improved system and the main conveyor is rotary in another structural arrangement of the improved system. Accordingly, described herein below are few objects of the present invention:

The main object of the present invention is to provide a simple and accurate improved system with customized steam cooking, popping, tearing and shell separator mechanisms for de-shelling cashew nut which comprises of a customized steaming system for customized steam cooking of each cashew nut, wherein based on signals from moisture sensors of the steaming system, the master controller releases pre-determined amount of pressurized steam according to different steam requirement for individual cashew nut according to their external and internal characteristic based on pre-determined master data, whereby such customized steamed cashew nuts enable accurate popping and accurate tearing each cashew nuts, thereby

ultimately avoiding high cashew kernel breakage and providing high percentage of substantially whole kernel as a final product, moreover this kind of customized steaming adapted for steaming cashew nuts provide good quality of kernels which has high market value.

It is another object of the present invention to provide an improved system which comprises of a specialized controlled feeding unit for controlled feed rate into the singulator unit and a specialized singulator unit which carries cashew nut from the feeding unit and places cashew nuts singly (one by one) on to a cashew cabin in an appropriate position and orientation, thereby guiding other systems like steaming system, popping system, tearing system and shell separator unit to work collaboratively for effective de-shelling without damaging inner whole kernel of the cashew nut.

It is still another object of the present invention to provide an improved system which comprises of an optics unit comprising of multiple programmable cameras which work at different frequencies of electromagnetic spectrum like visible, ultra-violet, infra-red, x-ray etc. for enhanced quality analysis of each cashew nut individually based on external and internal characteristics, thereby analyze individual cashew nut accurately for increasing efficiency of the improved system for de-shelling of cashew nuts.

It is still another object of the present invention to provide an improved system which is a multi-vision system which increases the reliability of accurate analysis of each cashew nut using multiple cameras at each optically active units in the improved system for providing accuracy of each operation like accurate popping, tearing and kernel separation from cashew nut shell which results finally into production of high quality commercially valuable cashew kernels.

It is further object of the present invention to provide an improved system which comprises of optically active systems like, popping system with multiple cameras, tearing system with multiple cameras, shell separator unit also with one or multiple cameras for effective analysis based on real time signals from said cameras to the master controller for effective respective operations.

It is still further object of the present invention is to provide an improved system which comprises of unique popping system with effective controlled popping mechanisms to provide a path to tearing, wherein each of the cashew nuts is popped at accurate popping point to create a slit at natural cleavage line based on real time signals from the multiple cameras and based on the analyzed inputs from the master controller.

It is another object of the present invention to provide an improved system which comprises of a specialized tearing system with specialized tearing mechanisms having controlled rotary cutting blade and a set of adjustable movable tongs to precisely tear open the cashew nut shell of every single cashew nut, wherein the tearing mechanism is controlled by the master controller based on real time signals from multiple cameras which enables accurate tearing of each cashew nut precisely.

It is further object of the present invention to provide an improved system which comprises of a specialized shell separator unit with at least one or more cameras and with fully automatic shell separator mechanism which works on real time signals provided by one or multiple cameras of the shell separator unit to the master controller for effectively and automatically separating cashew kernels from cashew nut shell unlike most of the existing cashew nut de-shelling systems where shell separation is mostly done manually, therefore is time-consuming and labor intensive work.

It is further object of the present invention to provide an improved system which comprises of separate collection units where different categories of cashew nuts and cashew shell are collected after shell separator mechanism, therefore the system is efficient in collecting whole kernels, broken or damaged kernels, and separated cashew nut shells into different collection units which is highly time-efficient task.

It is further object of the present invention to provide an improved system which is automated with electronically controlled essential mechanisms like feeding, steaming, popping mechanisms, tearing mechanism, and shell separation which enables the system as highly time-efficient in producing high quality cashew kernels.

It is further object of the present invention to provide an improved system to provide with customized steam cooking, popping, tearing and shell separator mechanisms for de-shelling cashew nut by analyzing individual cashew nut accurately on nut by nut basis based on different pre-defined parameters, therefore the process is rapid and time-efficient with high production rate of cashew nut de-shelling, moreover the improved process is accurate, highly reliable, and user friendly due to its labor independent nature which skips the skilled labor requirement for handling any operations of the process.

[0006] The above and other objects, features and advantages of the invention will best be understood from the following description of various embodiments thereof when read with reference to accompanying drawings and the accompanying drawings which illustrate embodiments of the invention are only exemplary drawings for the purposes of illustration and should not be construed as limited.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is an isometric view of an improved system with customized steam cooking, popping, tearing and shell separator mechanisms for de-shelling cashew nut which illustrates the entire assembly of different parts arranged in the improved system according to first embodiment of the present invention.

FIG. 2 is an elaborated isometric view of a horizontal main conveyor illustrating its constituting parts according to first embodiment of the present invention.

FIG. 3 is an elaborated isometric view of a customized steaming system illustrating constituting parts of the customized steaming system according to first embodiment of the present invention.

FIG. 4 is an elaborated isometric view of a popping system illustrating constituting parts of the popping system according to first embodiment of the present invention.

FIG. 5 is an elaborated isometric view of a single popping unit illustrating constituting parts of the popping unit showing arrangement of different parts of the single popping unit at the time of popping of individual cashew nut according to first embodiment of the present invention.

FIG. 6 is an elaborated isometric view of a tearing system illustrating constituting parts of the tearing system according to first embodiment of the present invention.

FIG. 7 is an elaborated isometric view of a tearing unit illustrating constituting parts of the tearing unit showing arrangement of different parts of the single tearing unit at the time of tearing of individual cashew nut according to first embodiment of the present invention.

FIG. 8 is an elaborated isometric view of a shell separator unit illustrating constituting parts of the shell separator unit showing entire arrangement of different parts of the shell separator

unit while separating cashew kernels from cashew nut shell according to first embodiment of the present invention.

FIG. 9 is a block diagram illustrating different non-limiting parts of the improved system by focusing the electronically controlled nature of the improved system according to first embodiment of the present invention.

FIG.10 is an isometric detailed view of an improved system for de-shelling cashew nut with customized steam cooking, popping and tearing mechanism which illustrates in detail the entire arrangement of different parts of the improved system with some constructional variation according to second embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0007] The present invention will now be described in a great detailed manner with reference to the exemplary accompanying drawings for the purposes of illustrating non-limiting embodiments of the present invention.

As used herein, the term 'cashew nut' and "cashew" are used interchangeably and both these terms refer to Cashew nut with shell (Raw Cashew Nut-RCN).

As used herein, the term 'cashew nut cabin' refers to a holding mechanism where a single cashew nut is held firmly in a single cashew nut cabin (cashew cup) in proper position and orientation.

As used herein, the 'main conveyor' referred in the system should always be construed as the 'main conveyor' on which multiple array of cashew nut cabins are mounted, wherein a single cashew nut is placed in each cashew nut cabin, and the movement of 'main conveyor' by default should be construed as movement of cashew cabin cups holding cashew nuts whenever there is any reference of movement of 'main conveyor' from one part of the system into another part for the purposes of the present invention. The 'main conveyor' can be a 'horizontal main conveyor' or a 'rotary main conveyor'.

As used herein, the term 'external and internal characteristics' shall refer to the characteristics including, but not limited to size, shape, surface properties, shell profile, shell thickness, distance between outermost kernel and inner side of shell or any other possible external and internal characteristics.

As used herein, the term 'optics unit' comprises of 'multiple cameras' and 'multiple light sources', wherein the light sources are specific light sources to ensure the enhanced surface analysis of each cashew nuts. The term 'multiple cameras' refer to 'multiple programmable

cameras' which are programmed as per the need of the invention for the purposes of the invention. These cameras can be "regular color" cameras or 'multi-spectral' cameras. The term 'multi-spectral' cameras work at different frequencies of electromagnetic spectrum like visible, ultra-violet, infra-red (IR), x-ray etc. for enhanced analysis of the cashew nut based on external and internal characteristics.

As used herein the term 'steam controller mechanism' may have an opening/closing valve or diaphragm or a flap, or any other possible element which falls within the scope of the present invention and the meaning of term should not be limited only to control the steam in steaming cups.

As used herein, the term 'popping' refers to 'opening of the region between head and knot of cashew nut' to develop a slit at its natural cleavage line's which is the weakest part of cashew nut and said region is the 'accurate popping region', whereas 'head of cashew nut' refers to 'accurate popping point' of the cashew nut.

As used herein, the term 'master controller' refers to a programmable controlling means which stores pre-determined master data related to external and internal characteristics of different cashew nuts. Multiple cameras of the optics unit use this pre-determined master data to decide category of each cashew nut present in optics unit and the moisture sensors of the customized steaming system compares this pre-determined master data to decide the pre-determined amount of pressurized steam and pre-determined temperature required, also to decide complete steaming is required or steaming required only at the weaker fibers of each cashew nut present in the customized steaming system. Other parts of the improved system like a feeding unit, popping system, tearing system and shell separator unit are coupled with the master controller through real time data/signals received from multiple feed sensors,

multiple cameras of the popping system, multiple cameras of the tearing system and one/multiple cameras of the shell separator unit for accurate popping point of cashew nut, accurate tearing point of cashew nut, and separation of shell from kernel respectively, thereby synchronizing all said parts for effective functioning.

As used herein, the speed of 'main conveyor' is controlled relatively with the speed of 'upper conveyor-1' of the steaming unit, 'upper conveyor-2' of the popping unit, and 'upper conveyor-3' of the tearing unit to synchronize with the speed of 'main conveyor' with for performing different operations like customized steaming, popping and tearing of cashew nuts respectively in an effective manner.

[0008] According to first embodiment of the present invention, referring to FIG.1, it is an isometric view of an improved system with customized steam cooking, popping, tearing and shell separator mechanisms for de-shelling cashew nut. FIG.1 illustrates more clearly the construction and relation to the several parts of the entire assembly of the improved system, wherein the main conveyor is horizontal in arrangement. The improved system comprises of at least one main frame (40); at least one hopper (39); at least one feeding unit (42); at least one singulator unit (43); at least one horizontal main conveyor (46) on which multiple arrays of cashew nut cabins are mounted; at least one optics unit (44); at least one customized steaming system (45); at least one popping system (47); at least one tearing system (48); at least one shell separator unit (49); at least one master controller; and multiple collection units, out of which few collection units are indicated as collection unit-1 (50), collection unit-2 (51), and collection unit-3 (53).

[0009] The main frame (40) supports different parts of the improved system which are arranged on or around the main frame to get a firm support from the main frame and to

absorb the vibration. The cashew nuts are fed into hopper (39) for receiving cashew nuts that are to be de-shelled. The feeding unit (42) which is connected downstream of said hopper (39) to receive cashew nuts fall from the hopper (39) into the feeding unit (42) due to the gravity. The feeding unit (42) is coupled to multiple feed sensors, and to at least one feed controller. The singulator unit (43) is connected to the feeding unit (42) for receiving cashew nuts from the feeding unit (42). Multiple feed sensors of the feeding unit (42) sense the feed rate of cashew nuts releasing from the feeding unit (42) into the singulator unit (43), and communicate same signals to the master controller which controls systematically the feed rate of cashew nuts passing from the feeding unit (42) towards the singulator unit through the feed controller as the feed controller is also coupled to the master controller. The horizontal main conveyor (46) is mounted on the main frame (40). The horizontal main conveyor (46) is having multiple arrays of cashew nut cabins which are mounted on the horizontal main conveyor (46). Each array of cashew nut cabins comprises of multiple cashew nut cabins. The singulator unit (43) carries cashew nuts from the feeding unit (42) to singulate cashew nuts, which are further placed by the singulator unit (43) on to the cashew nut cabins of the main conveyor (46) in a desired and pre-determined position and orientation. Each cashew nut cabin holds a single cashew nut appropriately and firmly in a desired, pre-determined position and orientation due to its specialized cashew holding mechanism. The horizontal main conveyor (46) moves successively and horizontally from the singulator unit (43) towards the optics unit (44), where cashew nuts of the horizontal main conveyor (46) are exposed to the optics unit (44). The optics unit (44) comprises of multiple cameras (Not shown in FIG. 1), and multiple light sources (Not shown in FIG. 1). In optics unit (44), each of the cashew nuts placed in individual cashew nut cabin is viewed

from multiple sides or multiple angles by multiple cameras and by capturing different images of each cashew nut in co-ordination of multiple light sources, analyze and process different images of each cashew nut based on different external and internal characteristics including size, shape, texture, surface properties, shell profile, shell thickness of individual cashew nut and the distance between outermost kernel and inner side of shell, along with other characteristics.

[0010] The optics unit after processing the image data, communicate signals related to analysis of different external and internal characteristics of individual cashew nut to the master controller. Further the horizontal main conveyor (46) with externally and internally analyzed cashew nuts moves successively and horizontally from the optics unit (44) into the customized steaming system (45). The customized steaming system comprises of an upper conveyor-1 (Not shown in FIG. 1) in which multiple steaming arrays are placed, wherein each steaming array comprises of multiple steaming units and each steaming array comprises of one or multiple moisture sensors, at least one steaming cup having multiple nozzles at its inner surface. The steaming cup of each steaming unit is connected to the steaming channel through steam controller mechanism. When the horizontal main conveyor (46) reaches to the customized steaming system (45), the upper conveyor-1 (Not shown in FIG. 1) of the customized steaming system (45) opens up and acts on cashew nuts of horizontal main conveyor (46), wherein multiple steaming arrays are arranged on the upper conveyor-1, wherein each steaming array comprises of multiple steaming units. The upper conveyor-1 moves synchronously with the horizontal main conveyor (46) due to controlled speed of both these conveyors. One steaming unit acts on single cashew nut of horizontal main conveyor (46). One/multiple moisture sensors of each steaming unit sense and

determine the exact shell moisture content, shell softness and steam requirement of each cashew nut and accordingly each cashew nut is steam cooked by releasing specific amount of pressurized steam through steam controller mechanisms of corresponding multiple steaming units signaled by the master controller based on pre-determined master data.

[0011] Further, the horizontal main conveyor (46) with these customized steamed each cashew nut successively and horizontally from the customized steaming system (45) into the popping system (47) for controlled popping of each cashew nut. The popping system (47) comprises of upper conveyor-2 (Not shown in FIG. 1) in which multiple arrays of popping units are arranged, wherein each array of popping units comprises of multiple popping units. Further each popping unit comprising of at least one camera and a popping mechanism. There is also a possibility of presence of multiple cameras in upper conveyor-2 instead of one camera in each popping unit. The upper conveyor-2 moves synchronously with the horizontal main conveyor (46) due to controlled movement of upper conveyor-2 and the horizontal main conveyor for effective popping of each cashew nut. Once this horizontal main conveyor (46) with customized steamed each cashew nut reaches the popping system (47), the upper conveyor-2 opens up the popping mechanism at each popping unit. One popping unit will act on one cashew nut placed in single cashew nut cabin of the horizontal main conveyor (46). Single camera of each popping unit continuously views one complete process of popping unit and sends real time signals about the state of corresponding popping process to the master controller continuously in real time, the master controller decides the accurate popping point and signals to the popping mechanism of each popping unit to pressurize corresponding cashew nut at its head which is the particular

popping point using impulsive force, thereby providing more accurate slit at its natural cleavage line to provide an accurate path for tearing of each cashew nut.

[0012] Further, the horizontal main conveyor (46) with popped cashew nuts placed on cashew nut cabin of the horizontal main conveyor (46) moves successively and horizontally from the popping system (47) to the tearing system (48). The tearing system (48) comprises of upper conveyor-3 (Not shown in FIG. 1) in which multiple arrays of tearing units are arranged, wherein each array of tearing unit comprises of multiple tearing units. Each tearing unit comprises of at least one camera and at least one tearing mechanism. There is also possibility of presence of multiple cameras in upper conveyor-3 instead of one camera in each tearing unit. The speed of the upper conveyor-3 and the speed of the horizontal main conveyor (46) are synchronized for effective tearing of each cashew nut. As the horizontal main conveyor (46) with popped cashew nuts placed on cashew nut cabin reaches the tearing system (48), the upper conveyor-3 opens up at least one tearing mechanism at single cashew nut of the horizontal main conveyor (46). The complete tearing process of one single tearing unit is viewed by one camera placed in single tearing unit, and each camera of each tearing unit continuously sends real time signals to the master controller about the state of corresponding tearing mechanism. After receiving such signals from the camera of each tearing unit, each of the steps involved in the tearing mechanism of each tearing unit is controlled by the master controller accordingly. Subsequently, the master controller decides the exact tearing point of each cashew nut and at this accurate tearing point of each cashew nut. Upon deciding the exact tearing point of each cashew nut, the master controller sends real time signals in turn to each tearing mechanism of corresponding tearing unit to tear open corresponding cashew nut to the required depth to enable easy

separation of whole kernel without causing any damage to the inner whole kernel. The tearing mechanism is fully controlled based on real time signals from corresponding camera of each tearing unit, thereby there is full control while tearing each cashew nut with controlled depth of the cut made into each cashew nut which leads to negligible chances of damaging inner whole kernel of the cashew nut. Further the horizontal main conveyor (46) with torn cashew nuts placed on cashew cabin of the horizontal main conveyor (46) moves successively and horizontally from the tearing system (48) to the shell separator system (49).

[0013] The shell separator unit (49) comprises of one or multiple cameras and a specialized shell separator mechanism. In the shell separator unit (49), each torn cashew nut is viewed, and analyzed by one or multiple cameras of the shell separator unit (49) to continuously sends real time signals to the master controller about the position of torn cashew nut to the master controller, which upon receiving such real time signals from the camera/cameras of the shell separator unit (49), subsequently, sends signals in turn to the shell separator mechanism of the shell separator unit (49) to act on each cashew nut to separate cashew kernel from cashew nut shell. This mixture of separated cashew kernel and cashew nut shell gets separated/segregated automatically into cashew kernel and cashew nut shell which gets collected separately into in at least two collection units as shown in FIG.1 as collection unit-1 (50) and collection unit-2 (51). The entire shell separation mechanism is fully controlled by the master controller based on real time signals from camera/cameras of the shell separator unit (49).

[0014] According to first embodiment of the present invention, referring to FIG. 2, it is an elaborated isometric view of a horizontal main conveyor illustrating its constituting parts, wherein this conveyor is one of the parts of an improved system of FIG. 1. As

illustrated the horizontal main conveyor (46) is mounted on the main frame (40). Multiple arrays of cashew nut cabins are mounted on the horizontal main conveyor (46). Each such array has multiple cashew nut cabins. One such cashew nut cabin is denoted by numerical indicator 41. Each cashew nut cabin (41) comprises of two parts namely lower part is a cashew nut cup holder which is fixed on the horizontal main conveyor (46) and the upper part of cashew nut cup cabin cashew nut cup fixed to receive a single cashew nut. Each cashew nut cabin (41) has specialized holding mechanism to hold each cashew nut singly and firmly in a desired and pre-determined position and orientation. The horizontal main conveyor (46) passes continuously, successively and horizontally through different parts of the improved system of FIG. 1 viz. the optics unit, the customized steaming system, the popping system, the tearing system, and the shell separator unit for synchronized operations of each part of the improved system for effective functioning. The speed of the horizontal main conveyor (46) and speed of all three upper conveyors namely upper conveyor-1, upper conveyor-2 and upper conveyor-3 is controlled for easy synchronization.

[0015] According to first embodiment of the present invention, referring to FIG. 3, it an elaborated isometric view of a customized steaming system illustrating constituting parts of the customized steaming system. The customized steaming system comprises of an upper conveyor-1 (81) in which multiple steaming arrays are placed, wherein each steaming array comprises of multiple steaming units. Each steaming unit comprises of one or multiple moisture sensors, at least one steaming cup (80) having multiple nozzles (86) at its inner surface, and each steaming cup is connected to the steaming channel (83) through steam controller mechanism (84). Out of multiple steaming units, few steaming units are shown as steaming unit-1 (91), steaming unit-2 (92) and steaming unit-3 (93). Due to synchronization

of horizontal main conveyor (46) with the upper conveyor-1 (81), the upper conveyor-1 (81) gets activated, opens up and one steaming unit of the steaming system acts on one cashew nut placed on one cashew nut cabin. After sensing of moisture present in the cashew nut shell of each cashew nut, moisture sensors signals about the exact shell moisture content, shell softness and steam requirement of corresponding cashew nut to the master controller as the moisture present inside each cashew nut shell is directly related to the pressure of the steam needs to be applied for its proper de-shelling,, the master controller controls the release of required specific amount of pressurized steam for specific period to corresponding cashew nut for customized steam cooking based on pre-determined master data through steam controller mechanism which comprises of a valve or a diaphragm or a flap, etc. Ex: The thickness of the shell will vary according to size of the cashew nut, therefore the master controller compares this data with the pre-determined master data to decide the amount of pressurized steam that may be needed to soften corresponding cashew nut precisely for customized steaming of corresponding cashew nut by ensuring that there is no under-steaming or over-steaming of each cashew nut. Once the steaming process starts, one or multiple moisture sensors of each steaming unit determines the amount of steam that is occupied in the cashew nut cabin, and accordingly the master controller can later control the release of pressurized steam for individual cashew nut cabin according to the differential steam requirement of each cashew nut (85) by opening or closing of corresponding steam controller mechanism held at corresponding cashew nut cabin (82). The customized steaming of each cashew nut is maintained easily due to presence of multiple nozzles of each steaming cup. The customized steaming of each cashew nut is carried out in such a way that it will enable easy and accurate popping and tearing process. The steaming process can

be either complete steaming or steaming the weaker fibers of the cashew nut that guides the effective popping and tearing process for easy separation of cashew nut kernel from the cashew nut shell. Each steaming unit of the steaming system has a pre-determined temperature ranged in between 150 °C to 450 °C and pre-determined pressure ranged in between 5 Kg/cm² to 10 Kg/cm² for pre-determined time period for customized steam cooking of each cashew nut according to variations in steam requirement.

[0016] According to first embodiment of the present invention, referring to FIG. 4, it is an elaborated isometric view of a popping system illustrating more clearly different parts of the popping system. The popping system comprises of upper conveyor-2 (64) in which multiple arrays of popping units are arranged, wherein each array of popping units comprises of multiple popping units. Further each popping unit comprising of at least one camera and a popping mechanism. Few popping units are shown as popping unit-1 (61), popping unit-2 (62), popping unit-3 (63). Each popping unit (61, 62 or 63) comprises of at least one camera and at least one popping mechanism. With continuous and successive movement of the main conveyor (46) with all customized steamed cashew nuts, the linear main conveyor reaches to the popping system to synchronize with the upper conveyor-2 (64), and thereupon the upper conveyor-2 (64) gets activated, opens up at least one popping mechanism at one single cashew nut. Upon receiving continuously real time signals from a single camera of each popping unit, the master controller measures the amount of pop required for each cashew nut and activates the popping mechanism by sending real time signal to the popping mechanism of corresponding popping unit to pressurizes their corresponding cashew nut at specific popping point (head of cashew nut) using impulsive force to provide more accurate slit for removing the cashew out of its shell.

[0017] According to first embodiment of the present invention, referring to FIG. 5, it is an elaborated isometric view of a single popping unit illustrating constituting parts. FIG. 5 shows the entire arrangement of different parts of the single popping unit at the time of popping of individual cashew nut. Each popping unit comprises of at least one camera (103) and at least one popping mechanism. Each popping mechanism acts on a single cashew nut (105) placed in single cashew nut cabin which is shown as a cashew nut cup (106) and a cashew nut cup holder (107). Each popping mechanism comprises of a holder (101) to hold a movable rod (102), an inverted 'V' plate (104), and a pusher rod (108). The inverted 'V' plate (104) holds the cashew nut (105) at its knot. The pusher rod (108) and inverted 'V' plate (104) are connected to the movable rod (102). The inverted 'V' plate comes and sits on knot of cashew nut. The camera (103) of each popping unit continuously fetches the images of different states/ positions of the cashew nut in the popping unit by clearly viewing the cashew nut in popping unit and sends real time signals about the state of corresponding cashew nut (105) to the master controller continuously. After receiving real time signals from the camera (103) of each popping unit, accordingly the master controller measures the amount of pop required for the cashew nut (105) and decides the accurate popping point of each cashew nut (105), at this accurate popping point the master controller sends real time signals in turn to the pusher rod (108) of corresponding popping mechanism of corresponding popping unit to pop/press/hit/ pressurizes corresponding cashew nut (105) at the accurate popping point which is the region between head of the cashew nut and the knot of the cashew nut using impulsive force, thereby providing more accurate slit at its natural cleavage line for providing easy and accurate path for tearing of corresponding cashew nut (105). Each of the steps

involved in the popping mechanism of each popping unit is controlled by master controller in real time to accurately pop the cashew nut (105) with desired force using the camera signals.

[0018] According to first embodiment of the present invention, referring to FIG. 6, it is an elaborated isometric view of a tearing system illustrating constituting parts. Accordingly, each tearing system comprises of upper conveyor-3 (71) in which multiple arrays of tearing units are arranged, wherein each array of tearing unit comprises of multiple tearing units. Multiple tearing units are shown as tearing unit-1 (72), tearing unit-2 (74) and tearing unit-3 (75). Each tearing unit comprises of at least one camera and at least one tearing mechanism. Each tearing mechanism acts on one cashew nut to tear open each cashew to the required depth.

When the horizontal main conveyor (46) with popped cashew nuts moves successively and horizontally from the popping system and reaches to the tearing system to synchronize with the upper conveyor-3 (71); the upper conveyor-3 (71) opens up at least one tearing mechanism at one single cashew nut wherein the tearing process takes place at each cashew nut by individual tearing mechanism of one tearing unit in a controlled manner. The speed of the upper conveyor-3 (71) and the horizontal main conveyor (46) is synchronized, controlled for effective tearing operation.

[0019] According to first embodiment of the present invention, referring to FIG. 7, it is an elaborated isometric view of a single tearing unit illustrating its constituting parts and their arrangement at the time of tearing of individual cashew nut. Each tearing unit comprises of at least one camera (211) and at least one tearing mechanism. One tearing mechanism acts

on one cashew nut (205) with a popped region (207). The cashew nut is shown to be placed in cashew nut cabin (206) held by a cashew nut cabin holder (212), and a movable joint (213).

[0020] Each tearing mechanism comprises of a movable rod (201), rotary cutting blade holder (202), a rotary cutting blade (203), movable tongs holder (210) for holding a set of movable tongs (209), 'V' support (208) at the lower meeting point of the set of movable tongs (209) through a movable joint (213). The design of set of movable tongs (209) is such that it has a 'V' support (208) at its ends through which the cashew shell is held firmly. The 'V' support (208) is designed in such a way that it is flexible so as to vary the distance between them. This flexibility of 'V' support (208) enables it to hold different sizes of cashew shell firmly. The rotary cutting blade (203) has different degree of freedom where it is free to move vertically, and the movement of rotary cutting blade (203) and movable tongs (209) are guided using camera (211) and their movements are controlled by the master controller. As one tearing unit acts on one single cashew nut, the single camera (211) of each tearing unit continuously view, measures and decides the exact tearing point of individual cashew nut (205) and continuously sends signals to the master controller about different positions of popped regions of cashew nut (205). After receiving said real time signals from the camera (211), the master controller directs the movable tongs (209) to hold the cashew shell firmly based on input from the camera (211) and also directs the rotary cutting blade (203) to insert into the popped region (207) of the cashew nut (205) to tear open the cashew nut (205). The rotary cutting blade (203) is moved accordingly to tear open the cashew nut accurately. The complete process is guided using camera (211) for effective tearing of cashew nut (205) without damaging the inner kernel of the cashew nut (205). To have a proper balance, both

upper conveyor-3 and conveyor will be moving with relative speed, such that effective tearing operation takes place.

[0021] According to first embodiment of the present invention, referring to FIG. 8, it is an elaborated isometric view of a shell separator unit illustrating its constituting parts. FIG. 8 shows the entire arrangement of different parts of the shell separator unit while separating a single cashew kernel from single cashew nut shell. The horizontal main conveyor further moves continuously, horizontally and successively to convey the torn cashew nuts into the shell separator unit. The shell separator unit comprises of one or multiple cameras and a specialized shell separator mechanism. The shell separator mechanism comprises of a tearing frame (93), a movable joint (92), a holding plate-1 (99), a holding plate-2 (95), a spring (94), 'C' fixture (91), a sub plate-1 (100), and a sub plate-2 (101). The holding plate-1 (99) and the holding plate-2 (95) are connected separately to two different movable joints (92) for free movement/rotation. The torn cashew nuts are passed through an arrangement where two different sub plates viz. sub plate-1 (100), and sub plate-2 (101) which insert into the torn region. Each torn cashew nut is viewed and analyzed continuously at torn region by one or multiple cameras which continuously send real time signals to the master controller about the position of torn region cashew nut. The master controller thereupon receiving such real time signals from one or multiple cameras, subsequently sends signals to the sub plate-1 (100) and sub plate-2 (101) of the shell separator mechanism, thereupon these plates (100 and 101) are moved in lateral/angular movement to open the cashew nut shell (98) simultaneously with pressing of back of cashew nut (97) by the 'C fixture' (91) to separate cashew kernel for easy separation. The 'C fixture' (91) is placed at the back of cashew nut through the spring (94) to push the cashew kernel. These cashew kernel and cashews nut shells are separated

automatically in the shell separator unit acts on each torn cashew nut to separate cashew kernel from cashew nut shell and the mixture of separated cashew kernel and cashew nut shell is separated automatically and are collected separately into at least three collection units, including cashew kernel in one collection unit, cashew nut shell into another collection unit and improperly popped cashew nut, broken pieces, un-separated shells, improperly torn or improperly cut cashew nuts are collected into still another collection unit.

[0022] According to first embodiment of the present invention, referring to FIG. 9, it is a block diagram of the improved system of FIG. 1. The improved system of FIG. 9 mainly focuses on the entire electronically controlled nature of the improved system depicting how the master controller controls essential parts of the improved system which significantly awards the automated nature to the system illustrated in FIG. 1 of first embodiment. Referring to FIG. 9, as shown cashew nuts are fed into the hopper (300) from where the cashew nuts pass into the feeding unit (301), wherein the feeding unit (301) is fully controlled by the master controller through feed controller (303) by receiving input signals from feed sensors (302) which sense the feed rate in the feeding unit (301). Cashew nuts further carried by the singulator unit (305), wherein the singulator unit carry cashew nuts and place cashew nuts so as to maintain one cashew nut in one cashew nut cabin of the horizontal main conveyor (306). Cashew nuts are carried to the optics unit (307), wherein the multiple cameras along with multiple light sources analyze each cashew nut based on their external and internal characteristics using pre-determined master data. These multiple cameras of the optics unit (307) signal to the master controller (304) about different external and internal characteristics of each cashew nut. Cashew nuts are carried to the customized steaming system (308) which comprises multiple moisture sensors (309) which are coupled to the master controller (304)

for customized steam cooking of individual cashew nut inside based on pre-determined master data. Customized cooked cashew nuts are now carried to the popping system (310) and from popping system comprising multiple popping arrays (311) for carrying out popping process, further into the tearing system (312) with multiple tearing arrays (313) for carrying out tearing process. From tearing system (312), cashew nuts are passed to the shell separator unit (314). The popping system (310), tearing system (312) and shell separator unit (314) are optically active parts of the improved system of FIG. 1 and these systems including popping system (310), tearing system (312) and shell separator unit (314) are coupled to the master controller (304) through cameras based on real time data for their controlled operations.

[0023] Many variations of the embodiment described in first embodiment of the present invention are possible. For example, in the second embodiment shown in FIG.10, one such variation which is mere constructional variation is described herein below.

[0024] According to second embodiment of the present invention, referring to FIG.10, it is an isometric detailed view of an improved system with customized steam cooking, popping, tearing and shell separator mechanisms for de-shelling cashew nut. For brevity, that detailed description of each and every part of the improved system of FIG. 10 is not repeated. Though, there is constructional variation in the improved system of first embodiment and second embodiment, said systems of first and second embodiment constitutes all parts as substantially same in their sequence and functioning resulting ultimately the substantially same end product, therefore the entire improved system of first embodiment and second embodiment is essentially the same, therefore constituting one and same invention. FIG. 10 illustrates in detail the entire arrangement of different parts of the improved system

with constructional variation in main conveyor compared to improved system of FIG. 1 of first embodiment.

[0025] The improved system illustrated in FIG. 10 constitutes essentially same parts and different construction/structure-wise only in shape and arrangement of the main conveyor. The improved system of first embodiment shares in common essentially all parts/features or mechanisms with second embodiment of the present invention and all these same parts of the improved system of first and second embodiments are arranged in exactly the same sequence. The improved system of second embodiment comprises: at least one main frame for supporting all parts located on or around the main frame (23), at least one hopper (24), at least one feeding unit (25), at least one singulator unit (26), at least one rotary/circular main conveyor (27) on which multiple arrays of cashew nut cabins (28) are mounted, at least one optics unit (29), at least one customized steaming system (30), at least one popping system (31), at least one tearing system (32), at least one shell separator unit (33), at least three collection units shown as collection unit-1 (35) and collection unit-2 (36), collection unit-3 (37) and at least one master controller to control entire functioning of the improved system of second embodiment. Moreover, said essentially all parts/features or mechanisms of the improved system of first and second embodiment functions essentially in the same manner to accomplish the desired result/same end product (properly de-shelled and separated cashew nut kernel from cashew nut shell) for the purposes of carrying out the same said improved process with customized steam cooking, popping, tearing and shell separator mechanisms for de-shelling cashew nut. The improved system described in FIG. 1 of first embodiment carries the cashew nuts in horizontally on horizontal main conveyor to/through different parts/units of the improved system, whereas the improved system described in FIG. 10 of second embodiment

carries the cashew nuts in circular path, where the cashew nuts are conveyed on rotary/circular main conveyor to/through different parts/units of the improved system. Both the improved systems as described in first and second embodiment are essentially same and should be construed as one invention only. It will be obvious that many changes and modifications may be made in the structure disclosed in FIG. 1 and FIG. 10 without departing from the spirit of the invention, defined in the claims.

[0026] According to third embodiment of the present, the invention discloses an improved process with customized steam cooking, popping, tearing and shell separator mechanisms for de-shelling cashew nut. The non-limiting steps involved in the improved process comprising the steps of:

Cashew nuts are subjected for feeding in bulk in hopper, from where said cashew nuts are subjected to feeding unit due to gravity, wherein the feed rate of the cashews nuts releasing from feeding unit is controlled wherein said feeding unit comprises of at least one feeder to accommodate flow of said cashew nuts, multiple feed sensors, at least one feed controller which is controlled by a master controller by receiving signals related to feed rate from multiple feed sensors of said feeding unit. Cashew nuts are subjected to singulation and after singulation the cashew nuts are placed singularly on the cashew nut cabins of the main conveyor. The main conveyor is either horizontal or rotary in structure. The main conveyor has multiple arrays of cashew nut cabins holding cashew nuts singly in cashew nut cabins in a desired and pre-determined position and orientation due to its cashew holding mechanism. Cashew nuts placed on the cashew nut cabins are carried now successively to get subjected for analysis into optics unit nuts, where cashew nuts are analyzed by multiple cameras along with

multiple light sources for viewing each cashew nut from multiple sides or multiple angles by capturing images of each cashew nut, by processing said images to analyze category of each cashew nut based on different external and internal characteristics to decide different categories of each said cashew nut based on pre-determined master data. Cashew nuts are carried successively synchronize with upper conveyor-1 having steaming system with lower main conveyor with multiple arrays of cashew nut cabins for effective steam cooking, thereby subjecting said cashew nuts for customized steam cooking in customized steaming system as per requirement of each said cashew nut based on pre-determined master data to release specific amount of pressurized steam for each cashew nut after sensing moisture content of individual cashew nut by moisture sensors, thereby avoiding over-steaming or under steaming as per requirement of each said cashew nut. One cashew nut is steam cooked by single steam controller mechanism for customized steam cooking. The cashew nuts are steam cooked in between the pre-determined temperature ranged in between 150°C to 450°C and a pre-determined pressure ranged in between 5 Kg/cm^2 to 10 Kg/cm^2 in said customized steaming system. Cashew nuts are carried successively to synchronize with upper conveyor-2 having popping system with lower main conveyor with multiple arrays of cashew nut cabins for accurate popping, thereby subjecting said cashew nuts for controlled popping system which is optically operative and said cashew nuts are popped controllably at accurate popping point by popping mechanism based on continuous real time signals from single camera for single cashew nut. Further cashew nuts are carried successively to synchronize with upper conveyor-3 having tearing system with lower main conveyor with multiple arrays of cashew nut cabins for accurate tearing, thereby subjecting said cashew nuts for controlled tearing in the tearing system which is optically operative and said cashew nuts are torn controllably at accurate

tearing point by tearing mechanism based on continuous real time signals from single camera for single cashew nut to get torn cashew nut; cashew nuts are carried successively for shell separation from torn cashew nut by shell separator mechanism based on continuous real time signal from one or more cameras to provide a mixture of separated cashew kernel and cashew nut shell which is subsequently, separated automatically and gets collected into at least three collection units as cashew kernel, cashew nut shell and improperly popped cashew nut, broken pieces, un-separated shells, improperly torn or improperly cut cashew nuts are also collected in separate collection unit;

[0027] As will be readily apparent to those skilled in the art, the present invention may easily be produced in other specific forms without departing from its essential characteristics. The present embodiments are, therefore, to be considered as merely illustrative and not restrictive, the scope of the invention being indicated by the claims rather than the foregoing description, and it will be appreciated that many variations in detail are possible without departing from the scope and spirit of the invention and all such variations therefore intended to be embraced therein.

WHAT IS CLAIMED IS:

1. An improved system with customized steam cooking, popping, tearing and shell separator mechanisms for de-shelling cashew nut, wherein the improved system comprising of:

- at least one main frame;

-at least one hopper supported on said main frame for receiving cashew nuts to be de-shelled;

- at least one feeding unit which is connected downstream of said hopper to receive said cashew nuts from said hopper due to the gravity, wherein said feeding unit is coupled to multiple feed sensors which sense feed rate of said cashew nuts releasing from said feeding unit and said feeding unit is also coupled to at least one feed controller to control feed rate of said cashew nuts before releasing from said feeding unit;

- at least one singulator unit which is connected to said feeding unit for receiving said cashew nuts from said feeding unit, wherein said feed controller control the feed rate of said cashew nuts before releasing from said feeding unit to said singulator unit which singulates said cashew nuts before releasing from said singulator unit;

-at least one horizontal main conveyor which is mounted on said main frame said singulator unit, wherein multiple arrays of cashew nut cabins are mounted on said horizontal main conveyor, wherein each array of cashew nut cabins comprises of multiple cashew nut cabins, and said singulator unit carries said cashew nuts from said feeding unit which are further placed by said singulator unit on to said cashew nut cabins of said conveyor in a desired and pre-determined position and orientation, wherein each cashew nut cabin holds a single cashew

nut appropriately and firmly in a desired, pre-determined position and orientation due to its specialized cashew holding mechanism.

-at least one optics unit which is placed next to said singulator unit on said main frame for receiving said cashew nuts placed singly on each said cashew nut cabin of said conveyor when said conveyor moves horizontally and successively from said singulator unit into said optics unit, wherein each said cashew nut is exposed to said optics unit, wherein said optics unit comprises of multiple cameras and multiple light sources, wherein said cameras view each said cashew nut from multiple sides or multiple angles and analyze images of each cashew nut, process, and analyze each said cashew nut in said optics unit based on different external and internal characteristics of said cashew nut to decide different categories of each said cashew nut and provide externally and internally analyzed each said cashew nut;

- at least one customized steaming system which is located next to said optics unit and connected to said main frame for receiving said externally and internally analyzed cashew nuts when said main conveyor moves horizontally and successively from said optics unit to said steaming system, wherein said steaming system comprises of: an upper conveyor-1 in which multiple steaming arrays are placed; each steaming array comprises of multiple steaming units, each steaming unit comprises of one or multiple moisture sensors; at least one steaming cup having multiple nozzles at its inner surface and said steaming cup is connected to at least one steaming channel through steam controller mechanism which comprises of a valve or a diaphragm or a flap to control the opening and closing of valve to control pressurized steam as per requirement of each said cashew nuts, wherein one steam controller mechanism acts on single cashew nut to provide customized steam cooked said cashew nut;

-at least one popping system which is located next to said customized steaming system and connected to said main frame for receiving said customized steamed each cashew nut when said horizontal main conveyor moves horizontally and successively from said customized steaming system to said popping system, said popping system comprises of upper conveyor-2 in which multiple arrays of popping units are arranged, wherein each array of popping units comprises of multiple popping units, further single popping unit acts on single cashew nut and said popping unit comprises of at least one camera and at least one popping mechanism, wherein said popping mechanism acts on said single cashew nut to pop at accurate popping point using impulsive force, thereby providing more accurate slit at its natural cleavage line to provide popped said cashew nut;

- at least one tearing system which is located next to said popping system and connected to said main frame for receiving said popped each cashew nut when said main conveyor moves horizontally and successively from said popping system into said tearing system, wherein said tearing system comprises of upper conveyor-3 in which multiple arrays of tearing units are arranged, wherein each array of tearing unit comprises of multiple tearing units, each tearing unit comprises of at least one camera and at least one tearing mechanism, wherein said tearing mechanism acts on single popped cashew nut to tear said cashew nut accurately at accurate tearing point of each cashew nut to provide controllably torn said cashew nut;

- at least one shell separator unit which is located next to said tearing system and connected to said main frame for receiving said controllably torn cashew nut when said main conveyor moves horizontally and successively from said tearing system; said shell separator unit comprises of one or multiple cameras and a shell separator mechanism, wherein said shell

separator mechanism open the cashew nut shell to separate the kernel from cashew nut shell, and after separation of cashew kernel from cashew nut shell, the mixture of cashew kernel and cashews nut shells are separated automatically to provide at least three categories as separated cashew kernels, separated cashew nut shells and separated improperly popped cashew nut, broken pieces, un-separated shells, improperly torn or improperly cut cashew nuts;

-at least three collection units which are adapted for collecting said three categories separately as cashew kernels, cashew nut shells and improperly popped cashew nut, broken pieces, un-separated shells, improperly torn or improperly cut cashew nuts; and

-at least one master controller which is coupled to said multiple feed sensors and said at least one feed controller of said feeding unit for controlling feed rate from said feeding unit; coupled to optics unit for receiving signals about externally and internally analysis of each cashew nut from said optics unit, thereby deciding category of each cashew nut present in said optics unit based on pre-determined master data; coupled to said one or more moisture sensors of each said steaming unit of said steaming system for controlling pressurized steam pressure in said steaming system through steam controller mechanism based on pre-determined master data to decide pre-determined amount of pressurized steam required by each cashew nut in said steaming system; coupled to said popping system for controlling popping mechanism of each cashew nut at accurate popping point of said each cashew nut to provide accurate path for tearing by receiving real time signals from every single camera of each said popping unit; coupled to said tearing unit for controlling said tearing mechanism for accurate tearing of each said cashew nut by receiving real time signals from said each camera of each said tearing unit; coupled to said shell separator unit for controlling automatic separation of said cashew kernels

from cashew nut shell by receiving real time signals from said each one or multiple cameras of each said shell separator unit to provide separated cashew kernel.

2. The improved system of claim 1, wherein due to synchronization of said main conveyor with said upper conveyor-1, said upper conveyor-1 gets activated, opens up so that one steaming unit of said steaming system acts on one cashew nut held in one cashew nut cabin, wherein one or multiple moisture sensors of said steaming unit sense the amount of moisture present in the cashew nut shell of corresponding cashew nut, moisture sensors signals about the exact shell moisture content, shell softness and steam requirement of corresponding cashew nut to said master controller, and said master controller checks a pre-determined master data to decide the exact amount of pressurized steam required by each cashew nut, to decide complete steaming is required or steaming only at the weaker fibers of said cashew nut is required, and thereupon said master controller releases a required specific amount of pressurized steam for specific period to corresponding cashew nut for customized steam cooking based on pre-determined master data through steam controller mechanism by ensuring that there is no under-steaming or over-steaming of each corresponding cashew nut, wherein steaming of each said cashew nut is either as per the requirement of said cashew nut based on pre-determined parameters.

3. The improved system of claim 1, wherein said popping mechanism of each said popping unit comprises of a holder to hold a movable rod, a pusher rod and an inverted 'V' plate which are connected to said movable rod, whereas 'V' plate holds the cashew nut at its knot, a single camera which continuously view and fetches images of different positions of said cashew nut of corresponding popping unit in real time including the horizontal movement of the pusher rod and sends real time signals to the master controller about different positions of said

corresponding cashew nut, thereby enabling said master controller to measure the amount of pop required for corresponding cashew nut and to decide the accurate popping point of corresponding cashew nut, thereupon said master controller sends real time signals about the accurate popping point of corresponding cashew nut to said pusher rod to pressurize corresponding cashew nut at accurate popping point with impulsive force, thereby providing more accurate slit at its natural cleavage line for providing easy to provide accurate path for tearing of each cashew nut.

4. The improved system of claim 1, wherein said tearing mechanism acts on single cashew nut with popped region, wherein each tearing mechanism comprises of a movable tongs holder for holding a set of two movable tongs which is a set of arms, a 'V' support is connected at lower meeting point of said set of two movable tongs through a movable joint and said two movable tongs are connected to one end of movable rod and other side of said movable rod is connected to a rotary cutter blade support on which rotary cutter blade is placed which has different degree of freedom with one degree as vertical, wherein cashew shell is held firmly by said 'v' support which is flexible to hold differently sized cashew nut shells, and the movements of rotary cutting blade and set of movable tongs are guided using at least one camera and said movements are controlled by said master controller, where said camera of each tearing unit continuously view different positions of popped regions of said cashew nut, measures and decides the exact tearing point of said cashew nut and continuously sends real time signals to said master controller about different positions of popped regions of cashew nut, upon receiving said real time signals from said camera, said master controller at accurate tearing point sends signals to said movable tongs to hold the cashew shell firmly at popped

region and also signals said rotary cutting blade to insert controllably into said popped region to accurately tear open the cashew nut without damaging inner whole kernel.

5. The improved system of claim 1, wherein said shell separator mechanism comprises of at least one tearing frame, at least one movable joint, at least one holding plate-1, at least one holding plate-2, at least one spring, at least one 'C' fixture, at least one sub plate-1, and at least one sub plate-2, and wherein when said torn cashew nuts are passed through an arrangement where two different sub plates including said sub plate-1 and said sub plate-2 are separately connected to two different holding plates including said holding plate-1 and said holding plate-2 respectively, further and said holding plate-1 and said holding plate-2 are connected separately to two movable joints for free movement; and when each torn cashew nut at its torn region is viewed and analyzed continuously by one or multiple cameras of the shell separator unit, to continuously send real time signals to the master controller about the position of each torn cashew nut, accordingly said master controller thereupon receiving such real time signals from said one or multiple cameras, subsequently further sends signals to said shell separator mechanism, to direct sub plate-1 and said sub plate-2 which are inserted into said torn region of said cashew nut, and are moved in lateral/angular movement to open the cashew nut shell to separate cashew kernel from cashew shell due to simultaneous pushing of said cashew nut from back by a 'C fixture' which is placed at the back of said cashew nut through a spring to push said cashew kernel for easy separation of each torn cashew nut kernel from cashew nut shell and the mixture obtained after separating cashew kernel from cashew nut shell is separated automatically and is collected separately into at least three collection units as cashew kernel, cashew nut shell, and improperly popped cashew nut, broken pieces, un-separated shells, improperly torn or improperly cut cashew nuts.

6. The improved system of claim 1, wherein the speed of the said main conveyor and speed of three said upper conveyors including upper conveyor-1, upper conveyor-2 and upper conveyor-3 is controlled for easy synchronization for effective operation of steaming, popping and tearing respectively, and when said main conveyor when moves horizontally and successively and reaches upper-conveyor-1, at least one steaming mechanism acts on each cashew nut of said main conveyor; when said main conveyor reaches upper-conveyor-2 controlled popping mechanism starts at each cashew nut; when said main conveyor reaches upper-conveyor-3, controlled tearing mechanism starts at each cashew.

7. The improved system of claim 1, wherein said cashew nuts are subjected to a pre-determined temperature ranged in between 150°C to 450°C and similarly said cashew nuts are subjected to a pre-determined pressure ranged in between 5 Kg/cm^2 to 10 Kg/cm^2 in said customized steaming system of said improved system.

8. An improved system with customized steam cooking, popping, tearing and shell separator mechanisms for de-shelling cashew nut, wherein the improved system comprising of:

- at least one main frame, at least one hopper for receiving cashew nuts to be de-shelled, at least one feeding unit to receive said cashew nuts from said hopper due to the gravity in a controlled manner through at least one feed controller for controlling feed rate before releasing from said feeding unit, wherein said feed rate is sensed by multiple feed sensors which are coupled to said feeding unit; at least one singulator unit for singulating said cashew nuts before releasing from said singulator unit; at least one rotary main conveyor on which multiple arrays of cashew nut cabins are mounted on said rotary main conveyor which moves in a circular path successively and continuously, wherein each array of cashew nut cabins

comprises of multiple cashew nut cabins on which cashews are placed singularly on to single cashew nut cabin of said rotary main conveyor in a desired and pre-determined position and orientation, where each cashew nut cabin of said rotary main conveyor holds a single cashew nut appropriately and firmly in a desired, pre-determined position and orientation due to its specialized cashew nut holding mechanism; at least one optics unit comprises of multiple cameras and multiple light sources, wherein said cameras view each said cashew nut from multiple sides or multiple angles and analyze each said cashew nut present in said optics unit based on comparison of different external and internal characteristics of cashew nut with pre-determined master data; at least one customized steaming system for steaming each cashew nut in said steaming system as per the individual requirement based on pre-determined master data, wherein said steaming system comprises of an upper conveyor-1 in which multiple steaming arrays are placed, each steaming array comprises of multiple steaming units, each steaming unit comprises of one or multiple moisture sensors and at least one steaming cup having multiple nozzles at its inner surface and said steaming cup of each steaming unit is connected to at least one steaming channel through at least one steam controller mechanism, wherein said steam controller mechanism comprises of a valve or a diaphragm or a flap to control the opening and closing of valve to control pressurized steam as per requirement of each said cashew nuts; at least one popping system comprising of upper conveyor-2 with multiple arrays of popping units for accurate popping of each cashew nut; at least one tearing system comprising of upper conveyor-3 with multiple arrays of tearing units for accurate tearing of each cashew nut, wherein said upper conveyor-1, upper conveyor-2, and upper conveyor-3 move synchronously with said rotary main conveyor with controlled speed, and wherein said popping system and said tearing system are optically operative through multiple

cameras; at least one shell separator unit comprises of one or multiple cameras and a shell separator mechanism, said shell separator unit which is optically operative through said at least one or multiple cameras, and wherein said shell separator mechanism separates cashew nut kernel from cashew nut shell, and after separation of cashew kernel from cashew nut shell, the mixture of cashew kernel and cashews nut shells is separated automatically to provide separated cashew kernels and cashew nut shells are collected in at least three collection units respectively as separated cashew kernel; cashew nut shell; and improperly popped cashew nut, broken pieces, un-separated shells, improperly torn or improperly cut cashew nuts; and at least one master controller which is coupled to feed controller to control said feed rate sensed by said feed sensors; coupled to said optics unit for receiving signals about externally and internally analysis of each cashew nut present in said optics unit based on pre-determined master data; coupled to said steaming system for controlling customized steam cooking of each cashew nut present in said steaming system based on pre-determined master data; coupled to said popping system, said tearing system and said shell separator unit for synchronizing and controlling functioning of said steaming system, said popping system and said tearing system respectively.

9. An improved process with customized steam cooking, popping, tearing and shell separator mechanisms for de-shelling cashew nut, wherein said process comprising the steps of:

-subjecting cashew nuts for feeding in bulk in hopper, from where said cashew nuts are subjected to feeding unit due to gravity, wherein the feed rate of the cashews nuts releasing from feeding unit is controlled wherein said feeding unit comprises of at least one feeder to accommodate flow of said cashew nuts, multiple feed sensors, at least one feed controller

which is controlled by a master controller by receiving signals related to feed rate from multiple feed sensors of said feeding unit;

- subjecting cashew nuts for singulation before releasing further;

- subjecting cashew nuts to place on a main conveyor which is either horizontal or rotary, said main conveyor are mounted with multiple arrays of cashew nut cabins holding cashew nuts singly in cashew nut cabins in a desired and pre-determined position and orientation due to its cashew holding mechanism and carrying said cashew nuts successively for analysis into an optics unit, wherein each cashew nut is analyzed by multiple cameras along with multiple light sources for viewing each said cashew nut from multiple sides or multiple angles, for capturing images of each cashew nut, for processing said images to analyze each said cashew nut in said optics unit based on different external and internal characteristics to decide different categories of each said cashew nut based on pre-determined master data;

- conveying said main conveyor continuously and successively to carry said cashew nuts placed on said main conveyor successively for synchronizing upper conveyor-1 having steaming system with lower main conveyor with multiple arrays of cashew nut cabins for effective steam cooking, thereby subjecting said cashew nuts for customized steam cooking in customized steaming system as per requirement of each said cashew nut based on pre-determined master data to release specific amount of pressurized steam for each cashew nut after sensing moisture content of individual cashew nut by moisture sensors, thereby avoiding over-steaming or under steaming as per requirement of each said cashew nuts, one cashew nut is steam cooked by single steam controller mechanism for customized steam cooking;

-carrying said cashew nuts successively for synchronizing upper conveyor-2 having popping system with lower main conveyor with multiple arrays of cashew nut cabins for accurate popping, thereby subjecting said cashew nuts for controlled popping system which is optically operative and said cashew nuts are popped controllably at accurate popping point by popping mechanism based on continuous real time signals from single camera for single cashew nut;

- carrying said cashew nuts successively for synchronizing upper conveyor-3 having tearing system with lower main conveyor with multiple arrays of cashew nut cabins for accurate tearing, thereby subjecting said cashew nuts for controlled tearing in the tearing system which is optically operative and said cashew nuts are torn controllably at accurate tearing point by tearing mechanism based on continuous real time signals from single camera for single cashew nut to get torn cashew nut; and

-carrying said cashew nuts successively for shell separation from torn cashew nut by shell separator mechanism based on continuous real time signal from one or more cameras to provide a mixture of separated cashew kernel and cashew nut shell which is subsequently, separated automatically into cashew kernel and cashew nut shell, and improperly popped cashew nut, broken pieces, un-separated shells, improperly torn or improperly cut cashew nuts which gets collected separately into at least three collection units.

10. The improved process of claim 9, wherein said cashew nuts are subjected to a pre-determined temperature ranged in between 150 °C to 450 °C and similarly said cashew nuts are subjected to a pre-determined pressure ranged in between 5 Kg/cm² to 10 Kg/cm² in said customized steaming system of said improved system.

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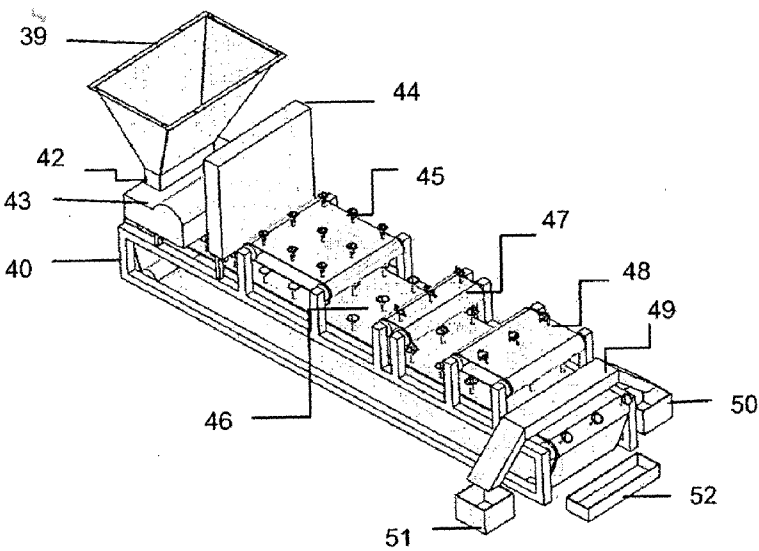


FIG. 1

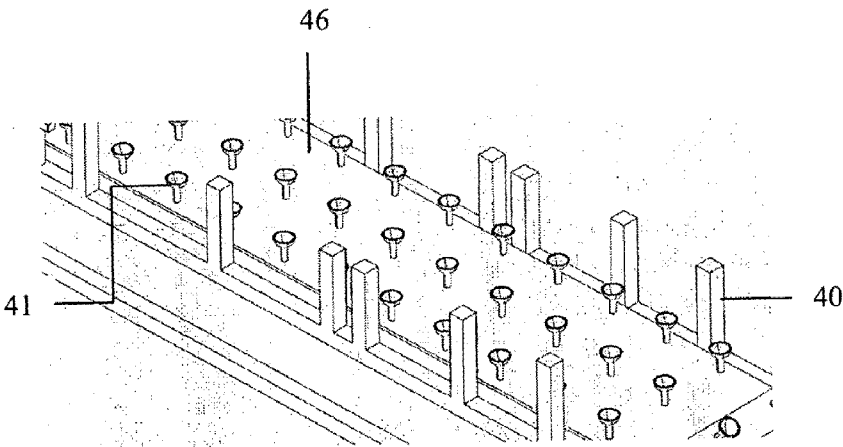


FIG. 2

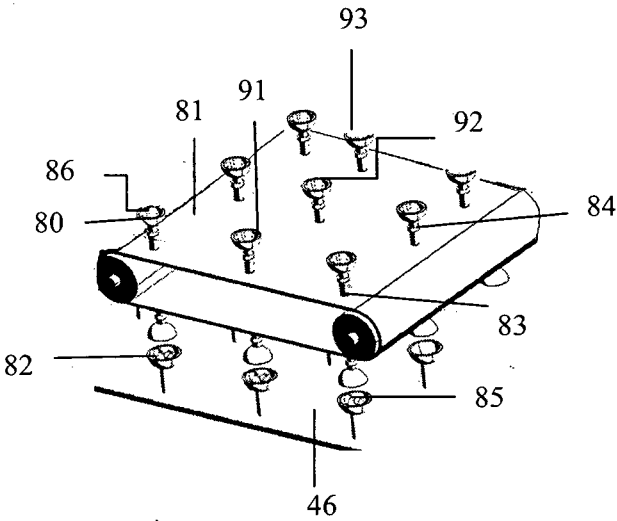


FIG. 3

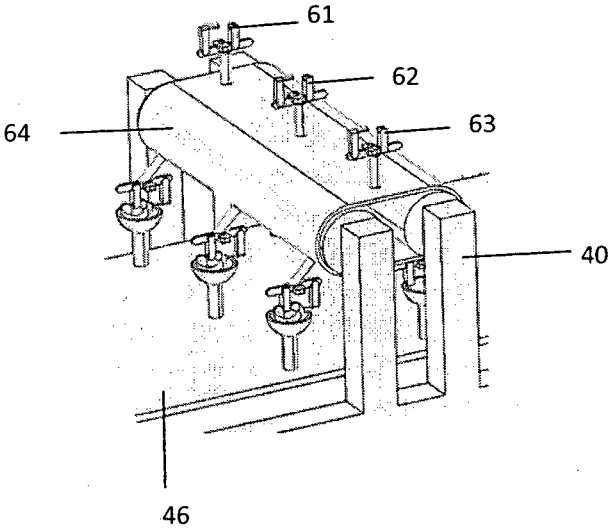


FIG. 4

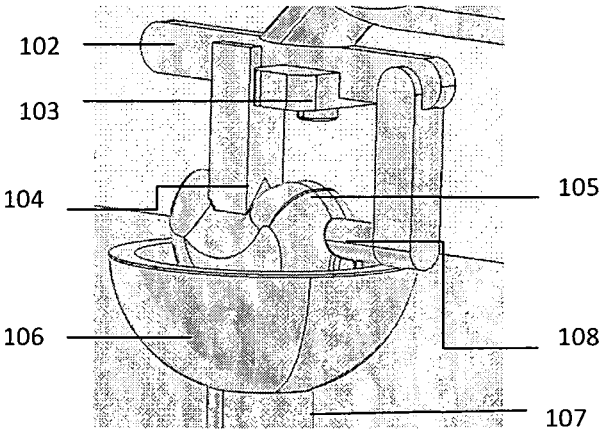


FIG. 5

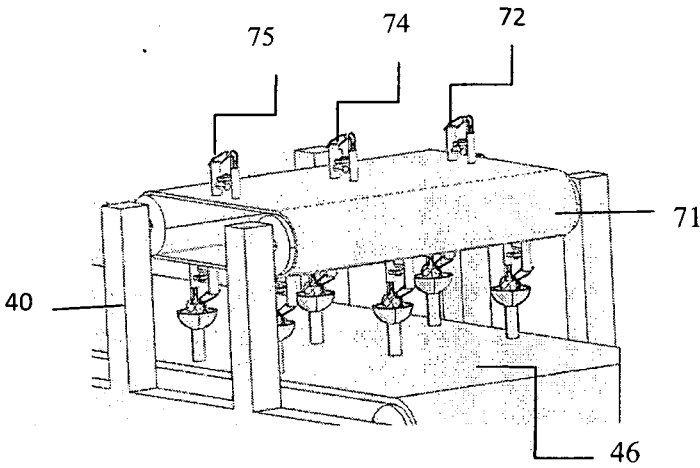


FIG. 6

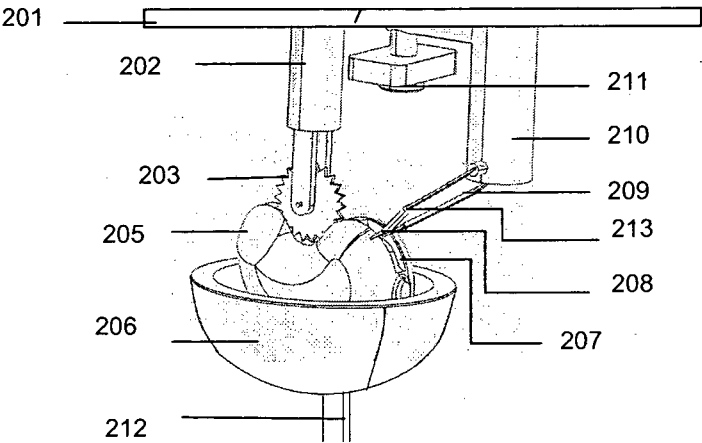


FIG. 7

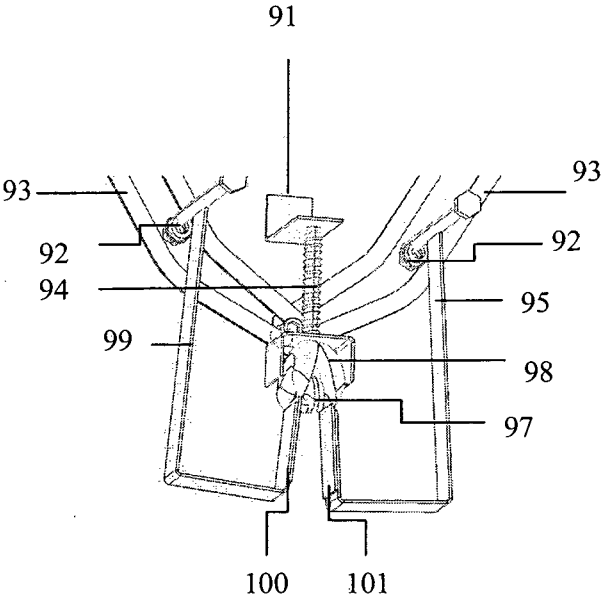
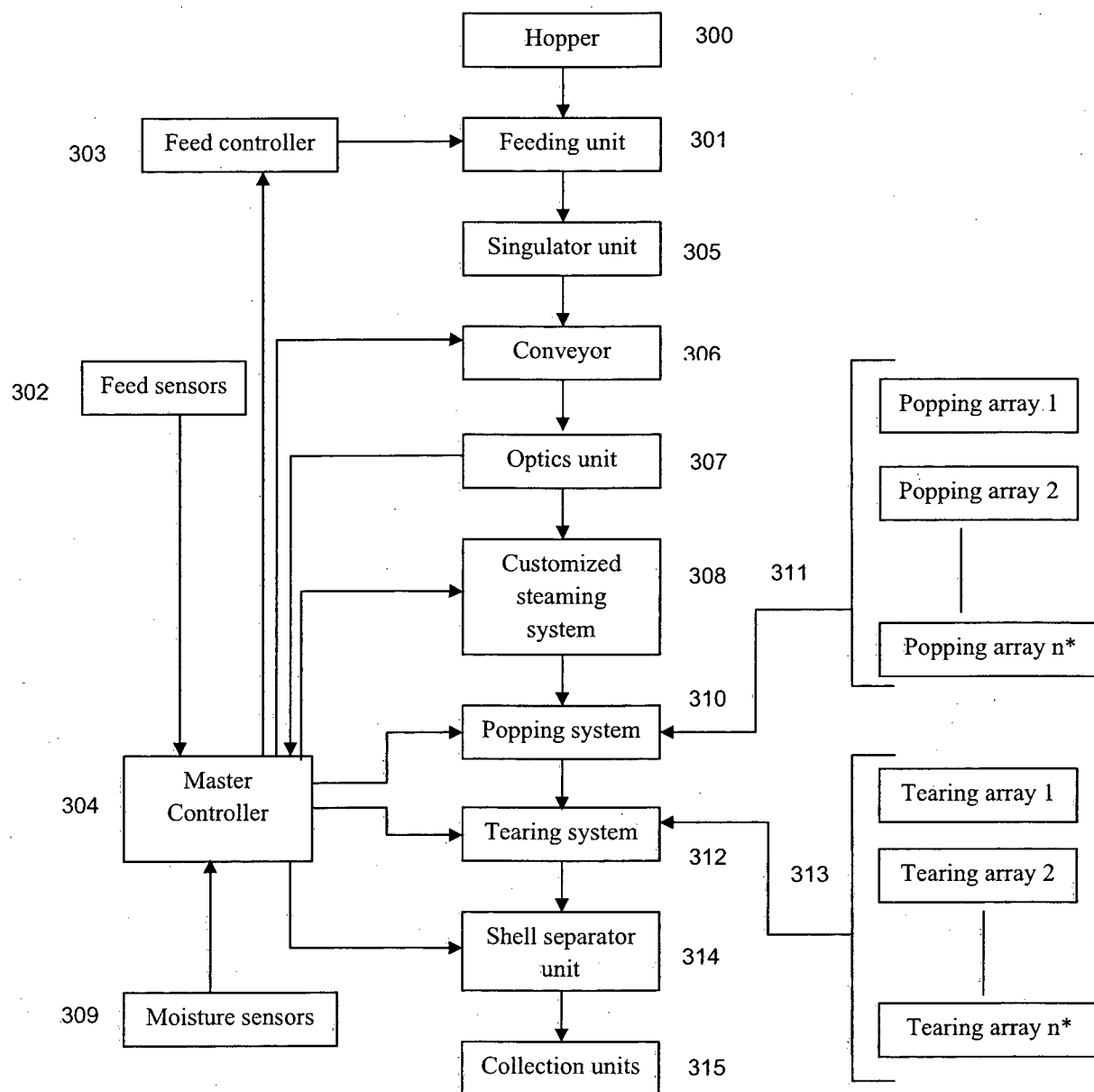


FIG. 8



(Where n* denotes a natural positive integer)

FIG. 9

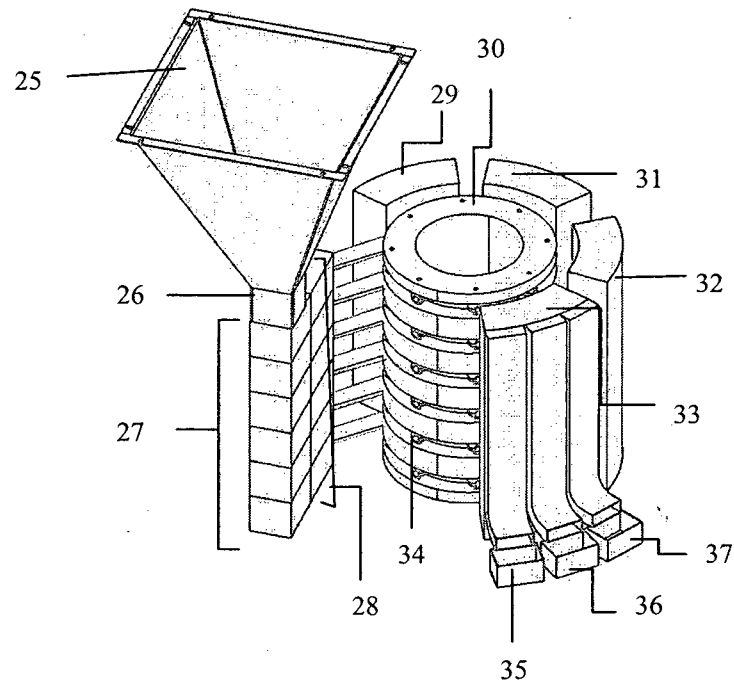


FIG. 10

INTERNATIONAL SEARCH REPORT

International application No.

PCT/IN 16/00083

A. CLASSIFICATION OF SUBJECT MATTER

IPC(8) - A23N 5/08, A47J 43/26, G05B 19/04, G06K 9/46, G06T 1/00 (2016.01)

CPC - A23N 5/08, A47J 43/26, G05B 19/04, G06K 9/46, G06K 2209/17, G06T 1/00, G06T 1/0014

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(8)- A23N 5/08, A47J 43/26, G05B 19/04, G06K 9/46, G06T 1/00 (2016.01);

CPC- A23N 5/08, A47J 43/26, G05B 19/04, G06K 9/46, G06K 2209/17, G06T 1/00, G06T 1/0014

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

USPC- 30/120.1, 99/568-599, 382/203, 460/1, 460/131, 460/134, 460/149, 700/19, 700/20, 700/117

Patents and NPL (classification, keyword; search terms below)

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

Pub West (US EP JP WO), Pat Base (AU BE BR CA CH CN DE DK EP ES FI FR GB IN JP KR SE TH TW US WO), Google Patent, Google Scholar, Google Web, FPO; search terms: shell, deshell, hull, split, nut, cashew, pistachio, pecan, walnut, almond, peanut, groundnut, cook, steam, blanch, microwave, pop, tear, separate, peel, image, camera, optical...

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2002/0172753 A1 (EHLERS et al.) 21 November 2002 (21.11.2002), para [0046], [0049], [0116], [0130]	1-10
A	US 6,059,117 A (NOVAK et al.) 09 May 2000 (09.05.2000), col 5, ln 35 to col 6, ln 48; col 9, ln 11-20	1-10
A	US 3,774,526 A (NEMIR) 27 November 1973 (27.11.1973), col 1, ln 37-55; col 2, ln 18-24; col 6, ln 40 to col 7, ln 6	1-10
A	US 2,284,879 A (NEMIR) 09 June 1939 (09.06.1939), pg 1, col 2, ln 34 to pg 2, ln col 1, ln 9; pg 2, col 2, ln 34-66	1-10
A, P	WO 2015/059720 A2 (MAHAJAN PRAKASH) 30 April 2015 (30.04.2015), pg 4, para 2 to pg 26, para 5	1-10

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

* Special categories of cited documents:

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

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Date of the actual completion of the international search

28 July 2016

Date of mailing of the international search report

22 AUG 2016

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