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(54) **APPARATUS AND SYSTEM FOR PREPARING EARS OF CORN FOR AUTOMATED HANDLING, POSITIONING AND ORIENTING**

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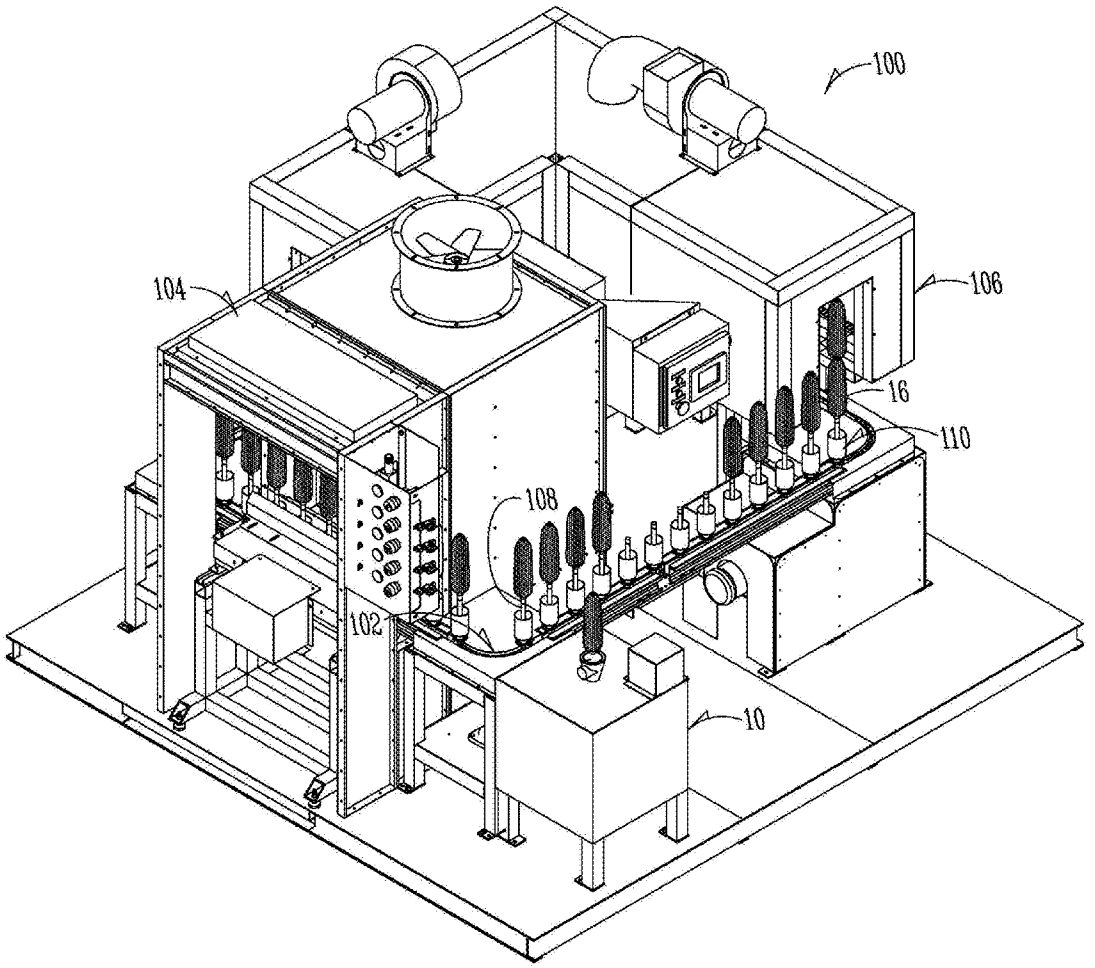
(57) **ABSTRACT**

An apparatus and system for automated handling, positioning and orienting of an ear of corn includes apparatuses and systems for altering a portion of an ear of corn. Optionally included are one or more stations for automatically processing, testing, sampling and preparing the ear of corn for processing, testing or sampling and an automated transport means automatically moving ears of corn from station to station using alterations made to the ear of corn.



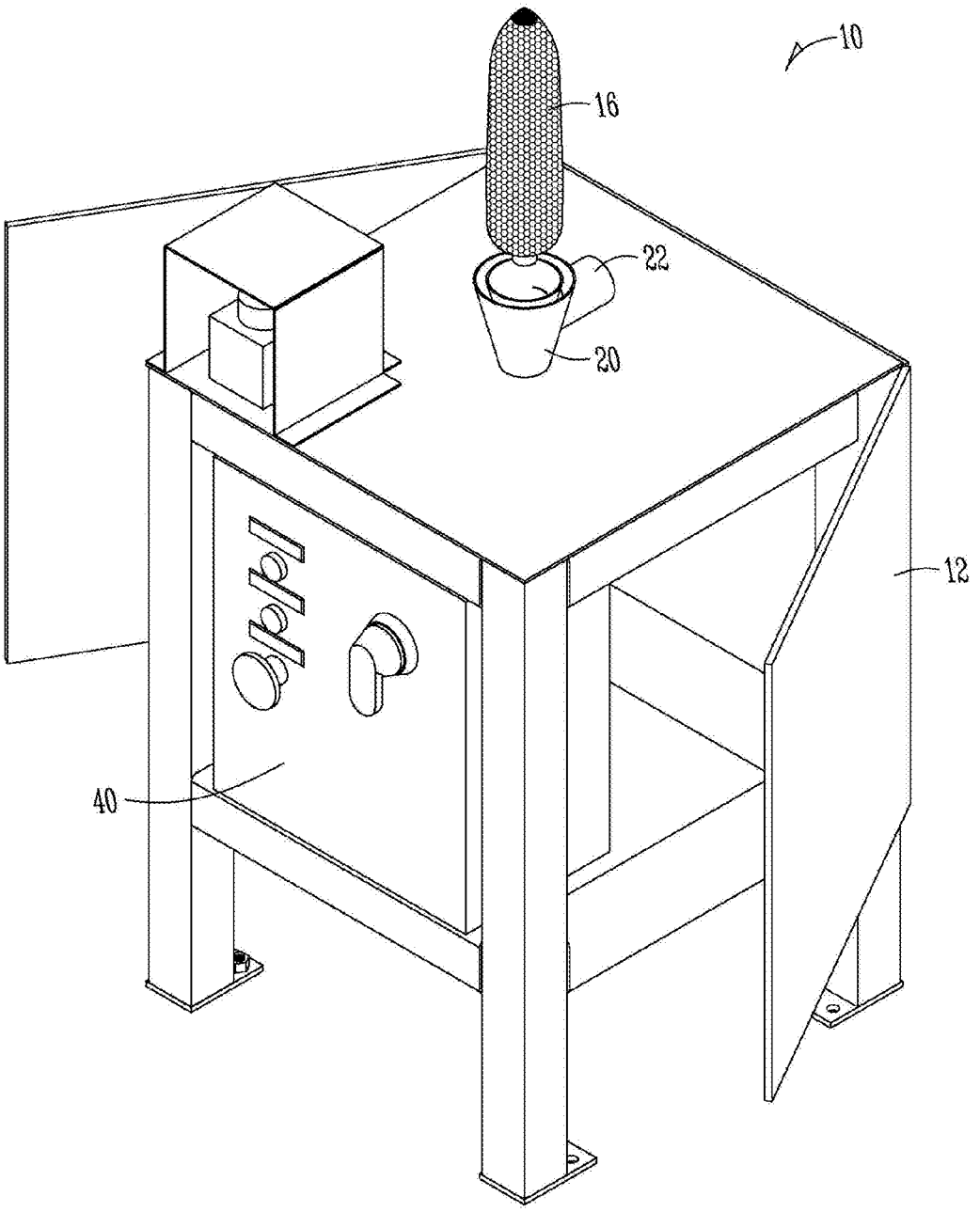


Fig. 1

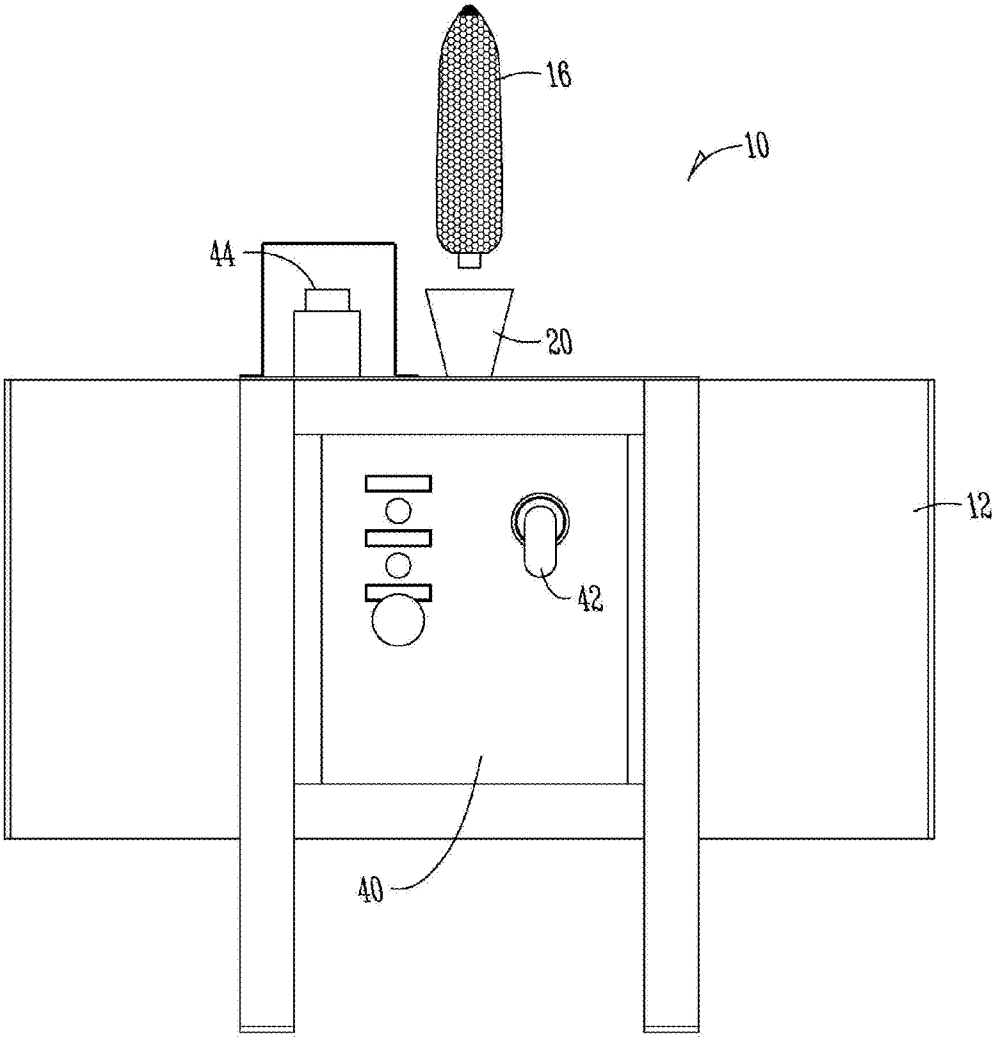


Fig.2

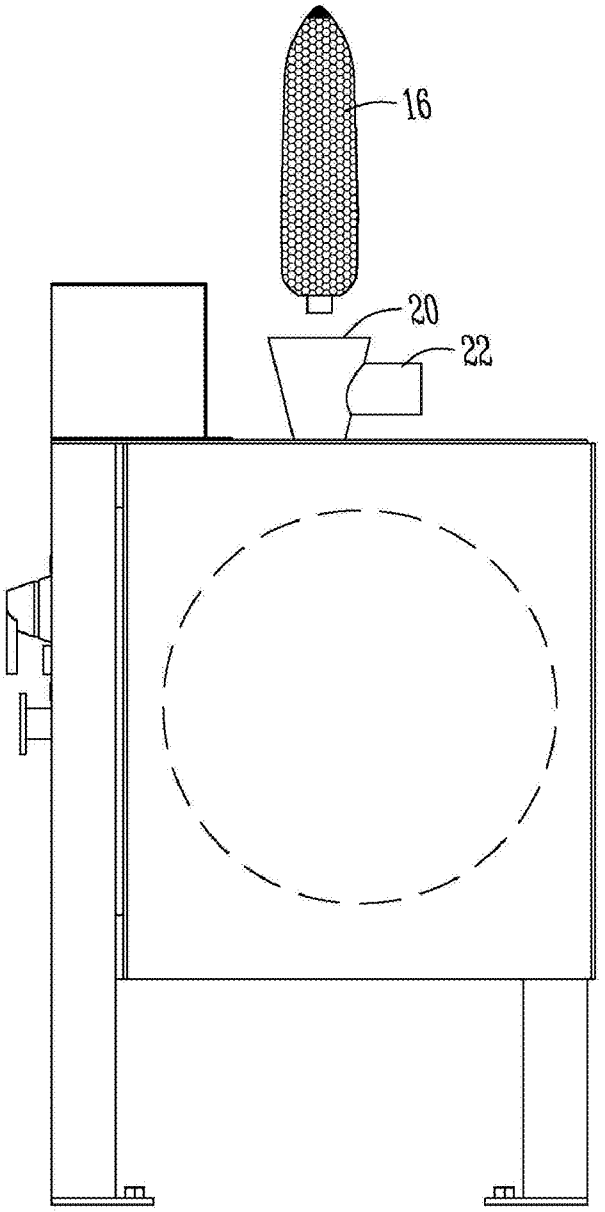


Fig. 3

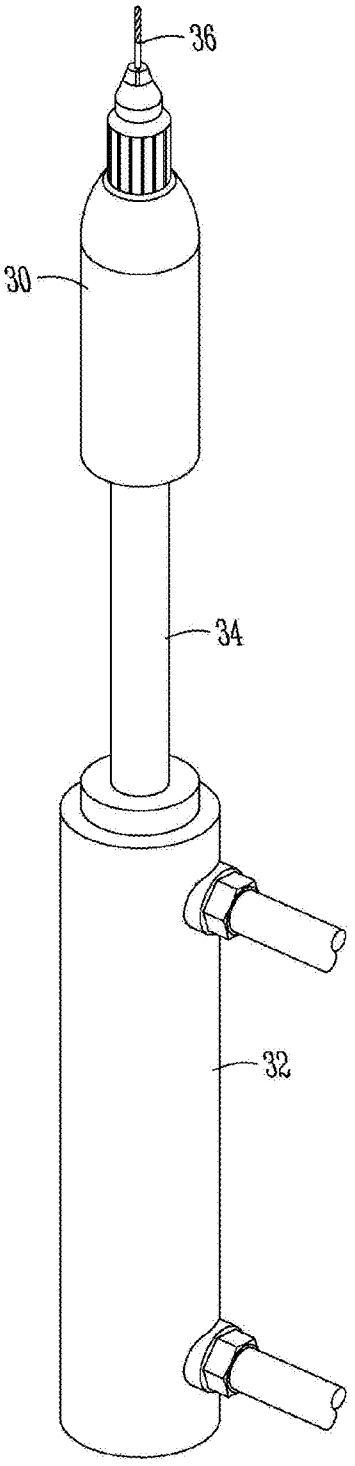


Fig. 4

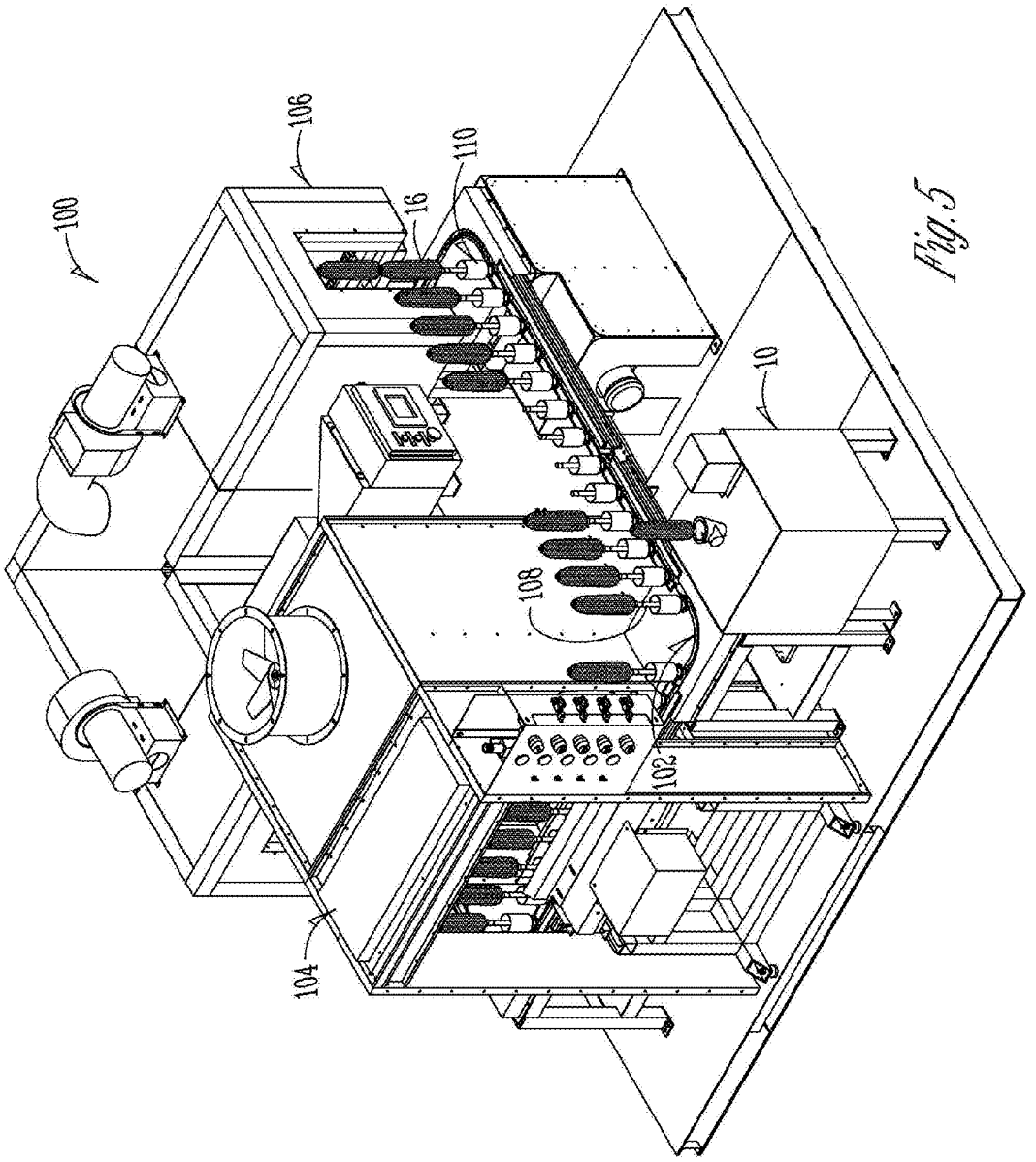


Fig. 5

APPARATUS AND SYSTEM FOR PREPARING EARS OF CORN FOR AUTOMATED HANDLING, POSITIONING AND ORIENTING

RELATED APPLICATIONS

[0001] This application claims priority under 35 U.S.C. §119 to provisional application Ser. No. 61/153,543 filed Feb. 18, 2009, which application is hereby incorporated by reference in its entirety.

FIELD OF THE INVENTION

[0002] The present invention relates to handling, positioning and orienting ears of corn. More particularly, the present invention relates to automated, high-throughput apparatuses and systems for altering ears of corn to provide for automated handling, positioning and orienting of the ear.

BACKGROUND

[0003] Apparatuses and systems for handling, positioning and/or orienting ears of corn for sampling purposes has been predominantly accomplished using manual techniques. Most manual techniques require unnecessary amounts of human involvement, which invariably limits the overall efficiency of the process. As companies try to conserve resources, time, money and manpower, techniques for automating processes otherwise performed manually are of increasing importance.

[0004] As more and more corn sampling methods and processes are automated, what is needed is an efficient and high-throughput handling, positioning and orienting apparatus and system for an ear of corn.

[0005] Therefore, it is a primary object, feature, or advantage of the present invention to improve over the state of the art.

[0006] It is a further object, feature, or advantage of the present invention to provide an apparatus and system for high-throughput handling, positioning and orienting of an ear of corn.

[0007] Another object, feature, or advantage of the present invention is to provide for an easy and safe apparatus and system for preparing an ear of corn for automated handling, positioning and orienting.

[0008] A still further object, feature, or advantage of the present invention is to provide apparatuses and systems for preparing an ear of corn for being handled, positioned and oriented in automated ear preparation and sampling processes.

[0009] Yet another object, feature, or advantage of the present invention is to provide an apparatus and system for preparing an ear of corn for being handled, positioned and oriented by automation.

[0010] A still further object, feature, or advantage of the present invention is to provide an apparatus and system for preparing an ear of corn for being handled, positioned and oriented by automation that automatically accounts for size and shape differences between each ear of corn.

[0011] Yet another object, feature, or advantage of the present invention is to provide an apparatus and system for preparing an ear of corn for being handled, positioned and oriented by automation which is user friendly, and safe to operate.

[0012] A still further object, feature, or advantage of the present invention is to provide an apparatus and system for preparing an ear of corn for being handled, positioned and oriented by automation which can be operated and performed by a single operator. These and/or other objects, features, or advantages of the present invention will become apparent. No single embodiment of the present invention need achieve all or any particular number of the foregoing objects, features, or advantages.

BRIEF SUMMARY

[0013] The invention generally provides an automated apparatus and system for preparing an ear of corn for being handled, positioned and/or oriented by one or more automated processes.

[0014] According to one aspect of the present invention, a system for automated handling, positioning and/or orienting of an ear of corn is disclosed. The system includes a station for altering a portion of an ear of corn. The station includes altering means for removing tissue from or appending material to the ear of corn to provide for automated handling, positioning and/or orienting of the ear of corn. The system may also include one or more stations automatically processing, testing, sampling and/or preparing the ear of corn for processing, testing and/or sampling. The system may also include transport means for automatically moving ears of corn from station to station. The transport means uses the altered portion of the ear of corn to handle, position and orient the ear of corn at and/or between the stations.

[0015] According to another aspect of the present invention, an apparatus for preparing an ear of corn for being handled, positioned and oriented by automation is disclosed. The apparatus includes a station for altering an ear of corn, holding means adapted for keeping the ear of corn in a desired position and orientation, and altering means. The altering means includes a tissue removal device having tissue removal means or a material appendage device having material appendage means for preparing a portion of the ear of corn to provide for automated handling, positioning and/or orienting of the ear of corn.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016] FIG. **1** is a perspective view of the apparatus.

[0017] FIG. **2** is a front view of the apparatus.

[0018] FIG. **3** is a side view of the apparatus.

[0019] FIG. **4** is a cut away side view of the interior of the apparatus.

[0020] FIG. **5** is a perspective view of a system using the apparatus shown in FIG. **1** according to an exemplary embodiment of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0021] The following description is merely exemplary in nature and is not intended to limit the present disclosure, application, or uses. For a better understanding of the invention, several exemplary embodiments will now be described in detail. Reference will be taken from time to time to the appended drawings. Reference numerals will be used to indicate certain parts or locations in the drawings. These same reference numerals will indicate the same parts or locations throughout the drawings, unless otherwise indicated.

Apparatus

[0022] The present invention discloses in one aspect an apparatus for preparing an ear of corn for being handled,

positioned and oriented by automation. One embodiment of apparatus **10** is shown in FIG. **1**. Apparatus **10** may be in the form of a station having at least the ability to alter an ear of corn for being handled, positioned and oriented by automation. Apparatus **10** may be partially or fully enclosed within cabinet **12**; alternatively, a frame or other supporting members may be fashioned, alone or in combination with another system for holding the various components of apparatus **10**. In a preferred form, apparatus **10** includes some holding means adapted for keeping the ear of corn in a desired position and orientation. The holding means may be full or semi-automated holding means. The present invention contemplates that the holding means could include any type of mechanical device that applies positive pressure to the ear of corn to keep the ear of corn in a desired position and orientation. Such mechanical devices may include grips, clamps, irises, a chuck, an expandable bladder or any other mechanical means for gripping or holding an ear of corn by the shank or some other portion of the ear. Other holding means are contemplated herein, such as pneumatic devices that generate a negative pressure (i.e., a vacuum) to keep the ear of corn in a desired position and orientation. One example of a pneumatic holding means is illustrated FIGS. **1-3**, which show a conofrustical recess **20**. Recess **20** is in operable communication with a vacuum to provide negative pressure or a vacuum force at the conofrustical recess **20** for retaining the ear of corn **16** in a desired position and orientation. Contemplation has also been given to holding means, such as support device that includes one or more support members for resting the ear of corn thereon. For example, rails, tubing or other guide members could be used to orient and keep the ear of corn in a desired position or orientation at apparatus **10** during altering. In the preferred form, the holding means provides for automated high-throughput positioning and orienting of ears of corn at apparatus **10**.

[0023] According to a preferred form of the present invention, apparatus **10** also includes altering means. Generally, the altering means provides some automated alteration of the ear of corn to allow for automated handling, positioning and orienting of the ear of corn. The altering means may be configured to alter each ear of corn by appending material to or removing material (tissue) from the ear of corn. For example, a tissue removal device having tissue removal means may be used for preparing a portion of the ear of corn to provide for automated handling, positioning and/or orienting of the ear of corn. Alternatively, a material appendage device having material appendage means may be used for preparing a portion of the ear of corn to provide for automated handling, positioning and/or orienting of the ear of corn. Depending on the desired type of alteration, apparatus **10** may include one or both types of altering means. In the case where apparatus **10** includes tissue removal means, contemplation is given in the present invention to an automated scraping tool having one or more edges for scrapping material from the ear of corn, an automated erosion tool having one or more liquid jets for eroding material from the ear of corn, or an automated cutting tool having one or more blades for cutting material from the ear of corn. In the case where material, such as ear tissue, is removed from the ear of corn, any of the aforementioned concepts may be used to create a hole or void in the ear of corn or clear tissue from a portion of the ear to provide a spot for holding the ear of corn. Boring a hole in the shank of the ear of corn or removing tissue (i.e., kernels) from the ear of corn may be accomplished specifically by using a drill bit, router bit, forstner bit, hollow boring tube, liquid jet cutter, or chisel. According to one aspect of the present invention, a pneumatically actuated drill (see FIG. **4**) may be used to create a hole in the shank of the ear of corn. In the case where material is being appended to an ear of corn, apparatus **10** may include an automated device adapted to append a member or material to the ear of corn to provide for automated positioning, handling and/or orienting of the ear of corn using the appended material or member. Various types of materials or members could be appended to the ear of corn whereby some automated system could use the appended materials or members to position, handle and/or orient the ear of corn. Materials such as magnetically active coatings could be applied to a portion of the ear of corn (i.e., the shank portion) whereby an automated process or system uses the coating to grip or hold onto the ear of corn. Alternatively, rigid structural members such as spindle, post, nail, or screw could be inserted into a portion of the ear of corn whereby some automated system could use the member to position, handle and/or orient the ear of corn. For example, an automated drill or impacting device could be used to append such members as a post, spindle, screw or nail to the ear of corn. In a preferred form of the present invention, the altering means is actuated into the holding means. For example, as shown in FIGS. **1-4**, drill **30** is actuated by piston **32** to engage ear of corn **16**. The present invention also contemplates that the holding means could be actuated into the altering means.

[0024] As shown in FIG. **5**, apparatus **10** may be used in combination with an automated system or process such as the "High Throughput Automated Apparatus, Method and System for Coating Ears of Corn" as shown and described in Provisional Application Ser. No. 61/090,979, filed Aug. 22, 2008, which application is assigned to the owner of the present application and incorporated by reference herein in its entirety. Automated system **100** may be configured for processing, testing or sampling the ear of corn. System **100** may also be configured for preparing the ear of corn for processing, testing or sampling. In the preferred configuration, automated system **100** would include some type of ear moving means for moving and/or positioning corn at and between stations. Alterations made to the ear of corn are configured to work in concert with the moving means, such as for example, where the ear moving means includes one or more features adapted to make use of the cavity, added material or appended structure to handle, position and/or orient the ear of corn by automation.

[0025] FIGS. **1-5** illustrate one exemplary embodiment configured to accomplish one or more of the objects, features or advantages of the present invention. FIG. **1** is a perspective view of apparatus **10** configured to alter an ear of corn **16** by tapping a hole into a portion of the ear of corn **16**. The apparatus **10** generally comprises a cabinet **12** upon which is mounted a control panel **40** and includes holding means, such as a conofrustical recess **20** having a drill cuttings suction port **22**. Within the interior of the cabinet **12**, as shown in FIG. **4**, is a tissue removal means, such as a drill **30** for drilling ear of corn **16** and piston **32** for advancing drill **30** and bit **36** into the shank or cob of ear of corn **16**. The present invention also contemplates that the ear of corn **16** could be moved into contact with drill **30**.

[0026] The conofrustical recess **20** has a cropped cone shape, as best shown in FIGS. **2** and **3**, for self-centering of the ear of corn **16** relative to drill **30**. The drill cuttings suction port **22**, as shown in FIG. **3**, is in operative communication

with the conofrustical recess **20** so that as suction is provided at the drill cuttings suction port **22** the pressure differential is communicated to the conofrustical recess **20**, thereby holding the ear of corn **16** in place. The drill cuttings suction port **22** removes cuttings and other debris from the conofrustical recess **20** as it is removed from the ear of corn **16** during the drilling process. The present invention is not limited to vacuum assisted retention of the ear of corn **16** within the conofrustical recess **20**. The present invention contemplates that other holding means could be used, such as any one of the holding means discussed previously. For example, holding means may include positive-pressure, self-adjusting grips that would secure the ear of corn **16** by gripping the shank. Other considerations include, but are not limited to, counter screws for screwing into the shank or cob of the ear of corn **16** for securing the ear or an inflatable bladder within the conofrustical recess that surrounds and captures the shank of the ear of corn **16** when set in the conofrustical recess **20**.

[0027] Also on cabinet **12** is a control panel **40**, as shown in FIG. **2**. Most importantly, the control panel includes a main disconnect **42** and a free hand safety switch **44**. Additionally, a light sensor (not shown) in operative communication with the control panel may be included in the conofrustical recess **20** at the appropriate depth to ensure that the ear of corn **16** is seated properly within the conofrustical recess **20** before engaging the drill **30** or allowing the drill **30** and bit **36** to be advanced into the shank of the ear of corn **16**. The sensor and free hand safety switch **44** provide adequate redundancy in safety to prevent the operator from accidentally coming into contact with drill bit **36**. The control panel **40** may also include controls for adjusting the drilling speed and depth of the tap into the ear of corn **16**. The main disconnect **42** is necessarily present so that power to the system can be disengaged for safety or maintenance purposes.

[0028] As shown in FIG. **4**, apparatus **10** further includes a drill **30** and piston **32**. The drill **30** is attached to the arm **34** of the piston so that the drill **30** and bit **36** may be raised or lowered to tap a hole into the shank of the ear of corn **16** using bit **36**. Preferably, the drill **30** and piston **32** are pneumatically powered from a centralized source. The rotational speed of the drill bit **36** and depth to which the ear of corn **16** is tapped (the extension of piston **32**) are monitored by an operator or electronically and controlled by the control panel **40**. Drill **30** is preferably pneumatic (e.g., PAR-A-MATIC self-feed drill, model no. 8255-A, Winnipeg, Manitoba, Calif.) and pneumatically actuated by piston **32**. Both drill **30** and piston **32** could be operated by a local or remote pneumatic pump. In the present invention, a hole is created in the shank of the ear of corn **16**. Preferably, the hole in the ear of corn **16** is used for handling, positioning and/or orienting the ear of corn **16**; however, the present invention contemplates that the hole created in the shank or cob of the ear of corn **16** could be used to inoculate the ear of corn **16**. Apparatus **10** could also be used to drill out and collect samples (the cuttings and debris) from each ear of corn **16** for testing. The apparatus **10** of the present invention could be used in combination with any automated system, such as system **100** shown in FIG. **5**, for processing, testing, sampling the ear of corn **16** and/or an automated machine for preparing the ear of corn **16** for processing, testing and/or sampling.

[0029] FIG. **5** illustrates one example of apparatus **10** functioning as a subsystem or station of an automated system **100**, such as the "High Throughput Automated Apparatus, Method and System for Coating Ears of Corn" as shown and described in Provisional Application Ser. No. 61/090,979, filed Aug. 22, 2008, which application is assigned to the owner of the present application and incorporated by reference herein in its entirety. FIG. **5** illustrates but one embodiment of apparatus **10** functioning as a subsystem or station of an automated system. One purpose of apparatus **10**, as can be seen from FIG. **5**, is to prepare the ear of corn **16** for processing, testing and/or sampling by automation. Apparatus **10** may also be used in combination with one or more automated systems for processing, testing, sampling the ear of corn **16**. By way of example, automated system **100** shown in FIG. **5** may include one or more types of automated transport means **102** for automatically moving ears of corn **16** from one processing station **104** to another processing station **106**. The automated transport means **102** may also be used to provide automated positioning, handling and/or orientation of the ear of corn **16** to facilitate processing of the ear of corn **16** at each processing station **104**, **106**. The present invention contemplates that the automated transport means **102** could be any type of shuttle, carriage, or conveyor, such as a chain-on edge conveyor spindle or drive **110** shown in FIG. **5**. The chain-on-edge conveyor spindle or drive **110** may include, for example, vertically oriented posts or spindles **108** intermittently spaced and attached along a continuous chain or belt that is cycled through one or more stations, such as processing stations **104**, **106**. Processing stations **104**, **106** could be any station or subsystem providing automated processing, testing, sampling and/or preparing the ear of corn **16** for processing, testing and/or sampling. The processing stations could include an automated ear coating station for coating each ear of corn **16** with a magnetically active coating, and an automated drying station for curing the coating. The present invention contemplates other coatings for applying to the ear of corn, such as fungicides. Processing stations **104**, **106** could also include any station or subsystem providing automated positioning of the coated kernels for seed testing. The kernels of corn separated from the cob could be positioned within the station collectively or individually using magnetic attenuation from a magnetic source. Using apparatus **10**, as described above, holes are drilled into the shank of each ear of corn **16**. The ear of corn **16** is mounted onto the vertically oriented spindle **108** using the hole drilled in the shank. Thus, using the connection between the hole tapped in the shank of the ear of corn **16** and the vertically oriented spindle, the ear of corn **16** may be handled, oriented and positioned at and/or between stations **104**, **106** by automation using transport means **102**.

Method

[0030] Also disclosed by the present invention is a method for preparing an ear of corn **16** for being handled, positioned and oriented by automated means, including semi and fully automated processes and/or systems. Generally, the method includes providing a station for altering an ear of corn and keeping the ear of corn in a desired position and orientation at the station. In one aspect, altering the ear of corn includes one or both of the steps of removing tissue from the ear of corn to provide for automated handling, positioning and/or orienting of the ear of corn, or appending material to the ear of corn to provide for automated handling, positioning and/or orienting of the ear of corn **16**. Steps contemplated for removing tissue include, but are not limited to, scraping tissue from the ear of corn, eroding tissue from the ear of corn, or cutting tissue from the ear of corn. In the case where material, such as ear

tissue, is removed from the ear of corn, any of the aforementioned concepts may be used to create a hole or void in the ear of corn or clear tissue from a portion of the ear to provide a spot for holding the ear of corn. Boring a hole in the shank of the ear of corn or removing tissue (i.e., kernels) from the ear of corn may be accomplished specifically by using a drill bit, router bit, forstner bit, hollow boring tube, liquid jet cutter, or chisel. According to one aspect of the present invention, a pneumatically actuated drill **30** (see FIG. **4**) may be used to create a hole in the shank of the ear of corn **16**. In the preferred method, the present invention provides for automated handling, positioning and/or orienting the ear of corn using the hole created in the ear of corn **16**. Tissue extracted or removed from the ear of corn **16** may be evacuated from the station using a vacuum in operative communication with the means for holding the ear of corn or the means for removing/extracting tissue from the ear of corn. In the case where material is being appended to an ear of corn, the method may include an automated device adapted to append a member or material to the ear of corn to provide for automated positioning, handling and/or orienting of the ear of corn using the appended material or member. Various types of materials or members could be appended to the ear of corn whereby some automated system could use the appended materials or members to position, handle and/or orient the ear of corn. Materials such as magnetically active coatings could be applied to a portion of the ear of corn (i.e., the shank portion) whereby an automated process or system uses the coating to grip or hold onto the ear of corn. Alternatively, rigid members or devices such as spindle **108**, post, nail, or screw could be inserted into a portion of the ear of corn whereby some automated system could use the rigid member or device to position, handle and/or orient the ear of corn. Automated means for appending, inserting, applying or connecting such materials as a magnetically active coating and/or rigid members or devices such as a screw, post, spindle or nail may be use for manipulating the ear of corn at each station. Methods contemplated for keeping the ear of corn in the desired position and orientation at the station include, but are not limited to, supporting, gripping, holding, stabilizing or retaining the ear of corn to keep the ear of corn in a desired position and orientation at the station and relative to the altering means. One method for keeping the ear of corn in the desired position and orientation at the station may include exposing a portion of the ear of corn (i.e., the shank portion) to positive or negative pressure or forces. Keeping the ear of corn in the desired position and orientation may include positive pressure mechanical devices such as grips, clamps, irises, a chuck, an expandable bladder or any other mechanical means for gripping or holding an ear of corn by the shank or some other portion of the ear. Negative pressure or vacuum pressure may also be used to keep the ear of corn in a desired position and orientation. One example of a pneumatic holding means is illustrated FIGS. **1-3**, which show a conofrustical recess **20**. Recess **20** is in operable communication with a vacuum to provide negative pressure or a vacuum force at the conofrustical recess **20** for retaining the ear of corn **16** in a desired position and orientation. Contemplation has also been given to holding means, such as support device that includes one or more support members for resting the ear of corn thereon. For example, rails, tubing or other guide members could be used to orient and keep the ear of corn in a desired position and orientation at apparatus **10** during altering. In the preferred form, the holding means as best illustrated in FIGS. **1-3** provides automated high-throughput positioning and orienting of ears of corn to help facilitate an alteration process whereby tissue is removed or material is appended to the ear of corn **16** to provide for automated handling, positioning and/or orienting of the ear of corn **16**.

[0031] As shown in FIG. **5**, methods of the present invention may be used in combination with an automated system or process. Automated system **100** may be configured for processing, testing or sampling an ear of corn **16**. System **100** may also be configured for preparing the ear of corn **16** for processing, testing or sampling. In the preferred configuration, automated system **100** would include some type of ear moving means **102** for moving and positioning corn at and between one or more work or processing stations **104** and **106**. Alterations made to the ear of corn **16** are configured to work in concert with the moving means **102**, such as for example, where the ear moving means **102** includes one or more features adapted to make use of the cavity, added material or appended structure to handle, position and/or orient the ear of corn **16** by automation.

[0032] FIGS. **1-5** illustrate exemplary methods configured to accomplish one or more of the objects, features or advantages of the present invention. The method includes using apparatus **10** for tapping a hole into the shank or cob portion of an ear of corn **16**. Apparatus **10** generally comprises a cabinet **12** upon which is mounted a control panel **40** and a conofrustical recess **20** having a drill cuttings suction port **22**. Within the interior of the cabinet **12**, as shown in FIG. **4**, is a drill **30** for drilling ear of corn **16** and piston **32** for advancing bit **36** into the shank or cob of each of corn **16**.

[0033] The conofrustical recess **20** has a cropped cone shape, as best shown in FIGS. **2** and **3**, for auto-centering the ear of corn **16** relative to drill **30**. The drill cuttings suction port **22**, as shown in FIG. **3**, is in operative communication with the conofrustical recess **20** so that as suction is provided at the drill cuttings suction port **22** the pressure differential is communicated to the conofrustical recess **20** thereby holding the ear of corn **16** in place using vacuum. The drill cuttings suction port **22** removes cuttings and other debris from the conofrustical recess **20** as it is removed from the ear of corn **16** during the drilling process.

[0034] One exemplary method of the present invention for preparing an ear of corn **16** for being handled, positioned and oriented by automation includes inserting an ear of corn **16** shank first into the conofrustical recess **20** for auto-centering the ear of corn **16** relative to the drill **30**, retaining the ear of corn **16** within the conofrustical recess **20** by vacuum, and automatically advancing the drill **30** and bit **36** into the shank of the ear of corn **16** for tapping a hole in the shank of the ear of corn **16**. The method also includes pneumatically actuating and advancing the drill **30** into the conofrustical recess **20** for tapping the hole in the shank or cob portion of each ear of corn **16**. Pneumatic advancement of drill **30** is provided by pneumatic piston **32** that is operated by a local or remotely positioned source, such as a compressor. Pneumatic piston **32** is of the type that is commercially available. Drill **30** is preferably a pneumatic drill (e.g., PAR-A-MATIC self-feed drill, model no. 8255-A, Winnipeg, Manitoba, Calif.). Although a pneumatic drill is preferred, the present invention contemplates substitution of other boring devices, such as an electric or hydraulic drill or impacting device, and including those previously described. Activating the free-hand safety switch **44** and tripping the sensor allows activation and advancement of the drill **30** and bit **36** into the shank of the ear of corn **16**. The

sensor (not shown) is tripped by inserting the ear of corn **16** into the conofrustical recess **20**, which in-turn activates drill cuttings suction port **22**, which by vacuum pressure helps retain the ear of corn **16** within the conofrustical recess **20** and evacuates cuttings from the drill **30** passing into the shank of the ear of corn **16**. In one embodiment, vacuum pressure supplied to the conofrustical recess **20** is continuously on, but at a pressure that allows manual or automated placement and removal of the ear of corn **16**. In an alternative embodiment, drill **30** cycles and the vacuum pressure supplied to the conofrustical recess **20** is turned off which allows the operator to remove the ear of corn **16** from the conofrustical recess **20** without the opposing vacuum force acting on the ear of corn **16**. The method of preparing an ear of corn **16** for being handled, positioned and oriented by automation could be in combination with an automated machine or system for testing, sampling and/or preparing the ear of corn **16** for testing and/or sampling. The automated machine, such as automated system **100** shown in FIG. **5**, may include a chain-on-edge conveyor spindle or drive **110** wherein the ear of corn **16** is automatically handled, positioned and oriented by insertion of the spindle **108** into the hole in the shank of the ear of corn **16**.

[0035] It should be appreciated that by using one method of the present invention, material removed or extracted from the ear of corn, such as for example where a hole is drilled in the shank of the ear, allows the ear of corn **16** to be handled, positioned and/or oriented in a high-throughput system, which in-turn allows for testing, sampling and/or preparing the ear of corn **16** for testing and/or sampling. In one aspect, this could include the high-throughput system having an automated transport means **102**, such as for example an automated transport means **102** having a spindle **108** for handling, positioning and/or orienting the ear of corn **16** by impaling the ear of corn **16** on the spindle **108** using the hole in the shank of the ear of corn **16**. In the case where material is appended to the ear of corn **16**, automated transport means **102** may be configured to grip or hold the material, such as a post or spindle, attached to the ear of corn **16**. The automated transport means **102** may be configured to pass the ears of corn **16** through one or more processing stations **104**, **106**. These stations **104**, **106** could include any station or subsystem providing automated processing, testing, and sampling of the ear of corn **16**, as well as any station or subsystem adapted for preparing the ear of corn **16** for processing, testing and/or sampling. As shown and described in Provisional Application Ser. No. 61/090,979, filed Aug. 22, 2008, entitled "High Throughput Automated Apparatus, Method and System for Coating Ears of Corn," processing stations **104**, **106** could include an automated ear coating station for coating each ear of corn **16** with a magnetically active coating and an automated drying station for curing the coating. Processing stations **104**, **106** could also include any station or subsystem providing automated positioning of the coated kernels for seed testing. The identification of each ear of corn **16** could be tracked individually or collectively. For example, one ear of corn **16** in each batch being processed could receive an identification tag for identifying the entire batch. Alternatively, each ear of corn **16** could be individually tagged for providing identification of each ear of corn **16** during processing or preparing the ear of corn **16** for processing.

System

[0036] Also disclosed by the present invention is a system for automated handling, positioning and/or orienting of an ear of corn **16**. The system for automated handling, positioning and/or orienting of an ear of corn includes a station for altering a portion of an ear of corn and altering means for removing tissue from or appending material to the ear of corn **16** to facilitate automated handling, positioning and/or orienting of the ear of corn. The system **100** may include one or more stations automatically processing, testing, sampling and/or preparing the ear of corn for automated processing, testing and/or sampling. Transport means **102** may also be provided for automatically moving ears of corn **16** from station to station (see generally **104** and **106**). The transport means **102** is configured for using the altered portion of the ear of corn to handle, position and orient the ear of corn at and between stations **104** and **106**. In a preferred form, the altering means of the system **100** includes, but is not limited to, material removal means operatively supported at the station, holding means for positioning and orienting the ear of corn relative to the material removal means, and actuation means for moving said holding means or material removal means for removing tissue from the portion of the ear of corn. The system contemplates altering means having material appending means operatively supported at the station, holding means for positioning and orienting the ear of corn relative to the material appending means, and actuation means for moving the holding means or material appending means for appending material to a portion of the ear of corn **16**. The system may include any semi- or fully-automated station adapted for processing, testing or sampling the ear of corn and/or preparing the ear of corn for processing, testing and/or sampling. Moving ears of corn at and between stations of system **100** could be accomplished by transport means, such as a shuttle, a carriage or a conveyor. One type of conveyor is shown in FIG. **5**, such as a chain-on-edge conveyor spindle or drive **102**.

[0037] FIG. **5** illustrates an exemplary system of the present invention. One example of the system includes apparatus **10** for automated tapping of a hole in the shank of the ear of corn **16**, one or more stations **104**, **106** for automatically processing, testing, sampling and/or preparing the ear of corn **116** for processing, testing and/or sampling, and some automated transport means **102** for automatically moving ears of corn **16** from station to station **104**, **106**. In the preferred form, the automated transport means **102** uses alterations made to the ear of corn **16**, such as a hole tapped in the shank of the ear of corn **16** to handle, position and orient the ear of corn **16** at and between stations **104**, **106**. The system includes apparatus **10** as described above. Apparatus **10** includes, but is not limited to, a drill **30** operatively supported within a cabinet **12**, a conofrustical recess **20** at the cabinet **12** and adapted for auto-centering the ear of corn **16** relative to the drill **30**, a vacuum assist system in operative communication with the conofrustical recess **20** for retaining the ear of corn **16** by vacuum pressure, and some actuation means for advancing the drill **30** and bit **36** into the shank of the ear of corn **16** for tapping a hole in the shank of the ear.

[0038] The present invention contemplates that the system **100** may include one or more processing stations **104**, **106** through which automated transport means **102** passes. The stations **104** and **106** may include any station or subsystem providing automated processing, testing, and sampling of the ear of corn **16**. Stations **104** and **106** could also be configured to prepare the ear of corn **16** for processing, testing and/or sampling. Processing stations **104**, **106** could include an automated ear coating station for coating each ear of corn **16** with a magnetically active coating and an automated drying station

for curing the coating. Processing stations **104**, **106** could also include any station or subsystem providing automated positioning of the coated kernels for seed testing, such as shown and illustrated in application Ser. Nos. 12/336,084 and 11/939,402, filed Dec. 16, 2008 and Nov. 13, 2007, respectively, which applications are assigned to the owner of the present application and are incorporated by reference herein in their entirety. The automated transport means **102** could include a shuttle, a carriage or a conveyor such as a chain-on-edge conveyor spindle or drive **110**. Using the hole prepared in the shank of the ear of corn **16**, the automated transport means **102** handles, orients and positions the ear of corn **16** as needed for each of the processes occurring at stations **104**, **106**. For example, the automated transport means **102** may be a chain-on-edge conveyor spindle **110** as shown in FIG. **5**. Each ear of corn **16** is impaled onto a spindle **108** by inserting the spindle **108** into the hole in the shank of the ear of corn **16**. The ear of corn **16** is then shuttled through various types of processing stations **104**, **106** of the system **100** for preparing or testing the ear of corn **16** and/or kernels on the ear of corn **16**. These processing stations could include stations **104**, **106** that prepare each ear of corn **16** for automated seed sampling processes, such as for example, where each kernel of corn is magnetically oriented by magnetic attenuation using a magnetically active coating applied to and cured on the crown of each kernel using stations **104**, **106**. In the case where material or some member is appended to the ear of corn **16**, such as a post, nail, screw, hook, spindle or other rigid structural member, provisions may be configured into the transport means for working in cooperation with the appended material or member for providing automated handling, positioning and/or orienting the ear. For example, in the case where a post is appended to the ear of corn, the automated transport means **102** may include a socket adapted to receive the post to provide handling, positioning and orienting of the ear **16** by automation.

[0039] The embodiments of the present invention have been set forth in the drawings and specification and although specific terms are employed, these are used in a generically descriptive sense only and are not used for purposes of limitation. Changes in the formed proportion of parts, as well as any substitutions of equivalences are contemplated as circumstances may suggest or are rendered expedient without departing from the spirit and scope of the invention as further defined in the following claims.

What is claimed is:

1. A system for automated handling, positioning and orienting an ear of corn comprising:

a station for altering a portion of an ear of corn;

altering means for removing tissue from or appending material to the ear of corn to provide for automated handling, positioning and orienting of the ear of corn;

one or more stations automatically processing, testing, sampling or preparing the ear of corn for processing, testing or sampling;

transport means automatically moving ears of corn from station to station; and

said transport means using said altered portion of the ear of corn to handle, position and orient the ear of corn.

2. The system of claim **1** wherein the altering means comprises:

a. material removal means operatively supported at the station;

b. holding means for positioning and orienting the ear of corn relative to the material removal means; and

c. actuation means for moving said holding means or material removal means for removing tissue from a portion of the ear of corn.

3. The system of claim **1** wherein the altering means comprises:

a. material appending means operatively supported at the station;

b. holding means for positioning and orienting the ear of corn relative to the material appending means; and

c. actuation means for moving said holding means or material appending means for appending material to a portion of the ear of corn.

4. The system of claim **1** wherein the one or more stations comprise:

a. stations adapted for processing, testing or sampling the ear of corn; or

b. stations adapted for preparing the ear of corn for processing, testing or sampling.

5. The system of claim **1** wherein the transport means comprises:

a. a shuttle;

b. a carriage; or

c. a conveyor;

6. The system of claim **1** wherein the transport means comprises a chain-on-edge conveyor spindle.

7. An apparatus for preparing an ear of corn for being handled, positioned and oriented by automation, the apparatus comprising:

a station for altering an ear of corn;

holding means adapted for keeping the ear of corn in a desired position and orientation at the station;

altering means comprising:

a. a tissue removal device comprising tissue removal means for preparing a portion of the ear of corn to provide for automated handling, positioning and orienting of the ear of corn; or

b. a material appendage device comprising material appendage means for preparing a portion of the ear of corn to provide for automated handling, positioning and orienting of the ear of corn.

8. The apparatus of claim **7** wherein the holding means comprises:

a. a mechanical device comprising a positive pressure applicator applied to the ear of corn;

b. a pneumatic device comprising a negative pressure applicator applied to the ear of corn; or

c. a support device comprising one or more support members for resting the ear of corn thereon.

9. The apparatus of claim **7** wherein:

a. the holding means is actuated to bring the ear of corn into engagement with said altering means; or

b. the altering means is actuated to engage the ear of corn held by said holding means.

10. The apparatus of claim **7** wherein said tissue removal means comprises:

a. an automated scraping tool having one or more edges for scrapping tissue from the ear of corn;

b. an automated erosion tool comprising one or more liquid jets for eroding tissue from the ear of corn; or

c. an automated cutting tool comprising one or more blades for cutting tissue from the ear of corn.

11. The apparatus of claim **7** wherein said material appendage means comprises an automated device adapted to append a member or material to the ear of corn, the ear of corn positioned, handled and oriented using the appended material.

12. The apparatus of claim **7** in combination with an automated system for processing, testing or sampling the ear of corn.

13. The apparatus of claim **7** in combination with an automated system for preparing the ear of corn for processing, testing or sampling.

14. The apparatus of claim **12** wherein the automated system comprises ear moving means for moving and positioning the ear of corn at and between one or more stations of the automated system.

15. The apparatus of claim **14** wherein said ear moving means comprises one or more features adapted to make use of the cavity, added material or appended structure to handle, position and orient the ear of corn.

16. An apparatus for altering an ear of corn for being handled, positioned and oriented by conveyance means configured to use the alteration made to the ear of corn, the apparatus comprising:

a station for altering an ear of corn;

holding means adapted for keeping the ear of corn in a desired position and orientation at the station; and

automated altering means at the station adapted to perform an alteration on a portion of the ear of corn.

17. The apparatus of claim **16** wherein the automated altering means comprises:

a. a material extraction tool comprising material extraction means for creating a hole in a portion of the ear of corn; or

b. a material appendage tool comprising material appendage means for appending a feature to the ear of corn to provide for automated handling, positioning and orienting of the ear of corn.

18. The apparatus of claim **17** in combination with an automated system comprising conveyance means, said conveyance means comprising a post whereby an ear of corn is handled, positioned and oriented by the conveyance means by impaling the ear of corn on the post.

19. The apparatus of claim **17** in combination with an automated system comprising conveyance means, said conveyance means comprises ear securing means whereby an ear of corn is handled, positioned and oriented by the conveyance means by gripping said feature appended to the ear of corn using said ear securing means.

20. The apparatus of claim **19** wherein said feature appended to the ear of corn comprises:

a. a rigid post;

b. a hook; or

c. a magnetically active coating.

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