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Title: IMPROVEMENTS IN AND RELATING TO AUTOMATED PRODUCE PROCESSING MACHINES

Abstract: An automated produce processing machine having a rotating drum defined, in part, by a plurality of cylindrical brushes, the automated produce processing machine having drum load sensing associated with a drum of the produce processing machine, a drum variable speed drive configured to rotate the drum, a control system having a processor configured to monitor the drum load, compare a measured drum load to a pre-defined drum load value stored in a memory associated with the processor, and display to an operator an indication of operating capacity versus a pre-defined maximum operating capacity for the machine which includes a comparison between the measured drum load and the pre-defined drum load value.
Improvements in and Relating to Automated Produce Processing Machines

TECHNICAL FIELD

The present invention relates to improvements in and relating to machines used for the automatic processing of produce. In particular the present invention relates to improvements concerning the automation of vegetable processing machines.

BACKGROUND ART

Post-harvest processing of produce is commonly employed for weighing, washing, polishing brushing and packing of produce. A prime example of the type of produce that is commonly processed post-harvest are root vegetables, a non-exhaustive list of which includes carrots, potatoes, yams, parsnips, beetroot, swedes, ginger etc.

Post-harvesting of root vegetables typically involves cleaning to remove loose dirt, fine roots and leafy matter. Processing may optionally involve polishing which provides a higher grade finish.

Processing machines such as cleaners and polishers typically employ a rotating drum and a plurality of cylindrical rotating brushes which form the walls of the drum. As produce passes through the drum it is rolled by the brushes. Loose matter brushed from the produce falls through the brushes and out of the machine.

Processing machines of this type use variable speed drives to control the rotation speed of the drum and brushes. An operator uses empirical observation and their own skill and experience to manually adjust the variable speed drives, input feed-rate and output feed-rate to achieve a desired level of cleaning / polishing. Manual control can be very effective if an operator is experienced and familiar with the machine. However, even for an experienced operator it is inconvenient to make all of the manual adjustments that are necessary to set up a machine.

This inconvenience is compounded by the need to also adjust the machinery that feeds the processing machine. During the processing operation the operator observes the produce exiting the machine and manually adjusts the infeed rate, the drum and brush speed and the produce volume in the machine if the produce requires more or less processing to achieve the desired finish. The reason for constant monitoring is due to the output finish varying as the infeed rate fluctuates as well as the machine becoming overloaded and potentially stalling if the infeed rate exceeds the outflow rate for a period of time.

It is also important for the operator to monitor the fluid levels of the machine and record running hours so that regular maintenance can be scheduled.
It is an object of the present invention to address the foregoing problems or at least to provide the public with a useful choice.

All references, including any patents or patent applications cited in this specification are hereby incorporated by reference. No admission is made that any reference constitutes prior art. The discussion of the references states what their authors assert, and the applicants reserve the right to challenge the accuracy and pertinency of the cited documents. It will be clearly understood that, although a number of prior art publications are referred to herein, this reference does not constitute an admission that any of these documents form part of the common general knowledge in the art, in New Zealand or in any other country.

Throughout this specification, the word "comprise", or variations thereof such as "comprises" or "comprising", will be understood to imply the inclusion of a stated element, integer or step, or group of elements integers or steps, but not the exclusion of any other element, integer or step, or group of elements, integers or steps.

Further aspects and advantages of the present invention will become apparent from the ensuing description which is given by way of example only.

**DEFINITIONS**

The term "produce processing machine" as used herein refers to machinery that is used for the processing of produce. Produce may take a number of forms, however they will typically be root vegetables such as potatoes, carrots, yams, turnips or the like. The processing of the vegetables may also take a number of forms, including, removing loose soil, washing, scrubbing and polishing.

The term "control system" as used herein refers to the electrical and electronic components used for monitoring and controlling a machines operation.

The term "processor" as used herein broadly refers to a microprocessor and its accompanying peripherals, such as power supply, memory, and any circuits necessary to interface between the processor and any device the processor controls or interfaces with, such as motor drives, I/O interfaces or the like.

The term "memory" as used herein refers to any computer readable medium used by the processor, such as RAM, ROM, hard drives, or the like.

The term "routine" as used herein refers to an electronic representation of a desired manner of operation of a machine. In particular a routine will include pre-defined set points or thresholds for sensed aspects of the machine. The control system activates, deactivates or adjusts actuators such as motors, solenoids and valves to adjust a sensed input to match a pre-defined set point. Routines typically relate to particular produce and/or processes to be performed by a machine.
The term “variable speed drive” as used herein refers to an electric motor having an electronically controllable rotational speed. It should be appreciated that any control electronics used for varying the rotational speed of a particular motor are included within the scope of the term. It is often the case that the drive electronics for a variable speed motor are separate from the motor.

**SUMMARY OF THE INVENTION**

The present invention relates to an automated produce processing machine. It is envisaged that the machine will be of the type that includes a rotating drum assembly which is formed from, in part, a plurality of cylindrical brushes. In use, the drum rotates in one direction and the brushes rotate in a counter direction. The drum is oriented to slope downwards from an input end to an outlet end. The downwards slope promotes a flow of produce within the drum from the input end to the output end. As produce progresses through the drum it is tumbled by the rotating drum and counter rotating brushes. This results in the produce being cleaned and/or polished depending on the configuration of the brushes.

According to a first aspect of the present invention there is provided an automated produce processing machine having a rotating drum defined, in part, by a plurality of cylindrical brushes, the automated produce processing machine having:

- drum load sensing associated with a drum of the produce processing machine;
- a drum variable speed drive configured to rotate the drum;
- a control system having a processor configured to:
  - monitor the drum load, and
  - compare a measured drum load to a pre-defined drum load value stored in a memory associated with the processor; and
  - display to an operator an indication of operating capacity versus a pre-defined maximum operating capacity for the machine which includes a comparison between the measured drum load and the pre-defined drum load value.

Preferably the plurality of rotating brushes are rotated by one or more brush variable speed drives.

The drum load sensing may be provided by one or more discrete sensing components, or may be incorporated into a component of the machine, such as a drum variable speed drive or circuitry controlling the drum variable speed drive.

In preferred embodiments the automated produce processing machine includes brush load sensing associated with the counter-rotating brushes.
The brush load sensing may be provided by one or more discrete sensing components, or may be incorporated into a component of the machine, such as a brush variable speed drive or circuitry controlling the brush variable speed drive.

Where both drum and brush variable speed drives are provided the control system processor is configured to compare both the measured drum load with the pre-defined drum load value as well as the measured brush load with a pre-defined brush load value stored in a memory associated with the processor.

According to a second aspect of the present invention there is provided an automated produce processing machine having a rotating drum defined, in part, by a plurality of cylindrical brushes, the automated produce processing machine having:

- drum load sensing associated with the rotating drum of the produce processing machine;
- a drum variable speed drive configured to rotate the drum;
- a control system having a processor configured to:
  
  o monitor the drum load, and
  
  o compare a measured drum load to a pre-defined drum load value stored in a memory associated with the processor; and
  
  o adjust the speed of the variable speed drive associated with the drum to alter the drum load to match the pre-defined drum-load value.

According to a third aspect of the present invention there is provided a method of operating an automated produce processing machine having a rotating drum defined, in part, by a plurality of cylindrical brushes, the automated produce processing machine having drum load sensing associated with a drum of the produce processing machine, a drum variable speed drive configured to rotate the drum, a control system having a processor configured to monitor the drum load and to adjust the speed of the variable speed drive based on the sensed load, the method including the steps of:

a) measuring a drum load by way of the drum load sensing;

b) comparing the measured drum load to a pre-defined drum load value stored in a memory associated with the processor; and

c) displaying to an operator an indication of operating capacity versus a pre-defined maximum operating capacity for the machine which includes a comparison between the measured drum load and the pre-defined drum load value.
According to a fourth aspect of the present invention there is provided a method of operating an automated produce processing machine having a rotating drum defined, in part, by a plurality of cylindrical brushes, the automated produce processing machine having a drum load sensing associated with the drum of the produce processing machine, a drum variable speed drive configured to rotate the drum, a control system having a processor configured to monitor the drum load and adjust the speed of the variable speed drive based on the sensed load, the method including the steps of:

d) measuring a drum load by way of the drum load sensing;

e) comparing the measured drum load to a pre-defined drum load value stored in a memory associated with the processor; and

f) adjusting the speed of the variable speed drive associated with the drum to alter the drum load to match the pre-defined drum-load value.

According to a fifth aspect of the present invention there is provided a control system for use with a produce processing machine having a rotating drum defined, in part, by a plurality of cylindrical brushes, the automated produce processing machine having drum load sensing associated with a drum of the produce processing machine, a drum variable speed drive configured to rotate the drum, the control system including:

• a processor;

• a memory associated with the processor;

• a plurality of inputs, one of the plurality of inputs being a drum load sensing input configured to monitor the drum load;

wherein the controller is configured to monitor an input associated with the drum load sensing, compare the sensed drum load with a pre-defined drum load value stored in the memory and outputting a signal representing the difference between the sensed drum load and the pre-defined drum load value.

According to a sixth aspect of the present invention there is provided a control system for use with a produce processing machine having a rotating drum defined, in part, by a plurality of cylindrical brushes, the automated produce processing machine having drum load sensing associated with a drum of the produce processing machine, a drum variable speed drive configured to rotate the drum, the control system including:

• a processor;

• a memory associated with the processor;
• a plurality of inputs, one of the plurality of inputs being a drum load input configured to monitor the drum load;

• a plurality of outputs, one of the plurality of outputs being a drum speed output configured to control the speed of the drum variable speed drive;

wherein the control system is configured to alter the output from the drum speed output based on the input received from the drum load input.

Preferred embodiments of the present invention may provide a number of advantages over the prior art, examples of which include:

• automated synchronisation of machines upstream and downstream of a produce processing machine;

• automated adjustment of machines upstream and downstream of a produce processing machine to control product flow;

• automated configuration of a produce processing machine based on pre-set routines such as product type, finish quality or a specific customers requirements;

• automated adjustment to compensate for irregular flow of produce or varying produce condition;

• automated monitoring of the produce processing machines operating hours;

• automated scheduling of maintenance cycles;

• remote monitoring and control of the produce processing machine; and

• reporting of machine utilisation.

BRIEF DESCRIPTION OF THE DRAWINGS

Further aspects of the present invention will become apparent from the ensuing description which is given by way of example only and with reference to the accompanying drawings in which:

Figure 1 is an isometric view of an automated produce processing machine;

Figure 2 shows a typical installation of a produce processing machine and associated machinery,

Figure 3 shows a flow diagram for the machine shown in Figure 1, and

Figure 4 shows a further flow diagram for the machine shown in Figure 1.
BEST MODES FOR CARRYING OUT THE INVENTION

The present invention relates to an automated produce processing machine. It is envisaged that the machine will be of the type shown in Figure 1, as generally indicated by designator 1, however the machine may vary in form without departing from the scope of the present invention.

Referring now to Figure 1, the produce processing machine 1 includes a rotating drum assembly 2 which is formed from, in part, a plurality of cylindrical brushes 3, of which only 3 are visible. In figure 1 access panels 4 in the sides of the produce processing machine are open to show the drum 2 and cylindrical brushes 3. In operation the drum 2 and cylindrical brushes 3 are not visible as the access panels will be closed in order to prevent water and dirt from escaping from the machine.

In use the drum 2 rotates in one direction and the brushes 3 rotate in a counter direction. The drum 2 is attached by way of a belt, not shown, to a drum variable speed drive, not shown, which is attached to the chassis 5 of the produce processing machine. The brushes 3 are rotated by a belt drive that is driven by a brush variable speed drive, not shown. The exact manner in which the drum and brushes are rotated by the variable speed drives is not pertinent to the present invention and may vary in any number of ways without departing from the scope of the invention. The type of variable speed drives utilised may also vary and as such the variable drive technology should not be seen as being limiting. Suitable variable speed drives may include, but should not be limited to, Brushless AC, Brushless DC, Brushed AC, Brushed DC.

A control system, not shown, is housed in an interface unit 6 which provides an operator interface through which the operator can operate the produce processing machine manually, or by selecting specific routines to run. Routines may be selected based on the product to be processed, or alternatively on the process to be performed.

The control system includes a processor, not shown in figure 1, which monitors the drum loading and brush loading. In some embodiments the drum load sensing is provided by way of a motor torque sensor or a drive current sensor that determines the current being supplied to the drum and brush variable speed drives. Alternative embodiments may use a variable speed drive controller that provides an output representative of the motor load and which can be provided to the control system.

In some embodiments the load may be determined by a combination of motor torque and rotational speed. In such embodiments a drive torque and speed sensor will be included for each of the variable speed drives.
In some embodiments the processor provides an output to the drum variable speed drive to either increase or decrease the speed of rotation of the drum. Increasing the drum speed results in a higher degree of produce agitation, greater produce to produce rubbing or cleaning, and increases the rate of produce throughput.

The speed of rotation of the brushes is typically varied independently of the drum speed. Increasing the brush speed results in more vigorous brushing and polishing. The brush speed is controlled depending on the produce and the process being performed. Other factors that have an effect on the produce include the rate at which fluid is dispensed within the produce processing machine and the position of the exit gate. Increasing the rate at which fluid is dispensed provides better produce to produce lubrication and a better polish. Reducing the rate at which fluid is dispensed generates a better scrubbing effect. Adjusting the exit gate governs the dwell time of produce in the machine as well as the depth of produce in the machine.

With reference to Figure 2 there is shown the produce processing machine 1 shown in Figure 1 in a typical factory installation. The installation shown in Figure 2 is by way of example only and it should be appreciated that the installation is in no way limiting on the present invention.

The installation shown in Figure 2 includes a number of additional pieces of equipment. From left to right these include an elevator 10 that delivers produce into a hopper 11. Produce is unloaded from transportation to the processing installation onto the elevator 10 which delivers the produce into hopper 11 by way of a hedgehog 19. The hedgehog provides an initial removal of some of the loose dirt, sprouts and vines from produce. The hopper includes a conveyor 12 which feeds produce to the produce processing machine 1. The hopper conveyor 12 has an adjustable feedrate which can be controlled by the produce processing machine 1 controller.

A recycle base 13 and filter screen are positioned beneath an opening, not shown, in the bottom of the produce processing machine 1. In use, any matter that is removed from the produce passing through the produce processing machine 1 falls through the opening and into the recycle base 13. Large matter, such as grass, roots or the like is captured by the filter screen and transported to a waste bin. Other matter such as smaller dirt particles and fluid is captured in the recycle base. The captured fluid may come from the produce but will primarily comprise wash fluid that is used in the produce processing machine 1.

The recycle base 13 includes a recycle pump, not shown, which pumps fluid captured in the recycle base back into the produce processing machine 1 to be re-used for processing of further produce. A scavenge pump is also provided in the recycle base to remove excess water should the fluid level in the recycle base become too high. The recycle base incorporates a fluid level sensor, not shown, which provides a fluid level indication back to the produce processing machine 1 control system. The produce processing machine 1 control system controls the recycle pump and the scavenge pump as well as the filter screen drive if one is present.
The rate of flow of produce through the produce processing machine 1 is controlled by the speed of rotation of the drum and brushes as well as the angular position of the produce processing machine 1 exit gate 14. Adjusting the angular position of the exit gate 14 along with the rate at which produce is fed into the produce processing machine 1 controls the volume of produce that is in the machine. The angular position of the exit gate 14 also allows the produce to build up to a desired depth; this action creates pressure on the produce adjacent the brushes, thereby increasing the effective brushing pressure. The exit gate 14 discharges produce from the produce processing machine 1 onto a chute 15, or optionally a drying roller 16 depending on the produce being processed. The chute/produce dryer feeds produce onto inspection conveyor 17 which in turn feeds produce onto roller sizer 18 which sorts the produce into different sizes.

In use, an operator uses operator interface 6 to issue commands to the produce processing machine 1 control system, not shown. A typical operator interaction involves, for example, the selection of a produce type and the processing operation required. For example heavily soiled produce may require a longer processing time than the same produce with only light soiling.

Once an operator has input the necessary data the control system accesses an associated memory and retrieves an operating profile 99 comprising a series of computer readable instructions relating to the commands entered by the operator.

The flow diagram of Figure 3 shows the steps the control system takes once a routine is retrieved and initiated and where a fully automated system has been implemented.

The flow diagram of Figure 4 shows the steps the control system takes once a routine is retrieved and initiated by an operator in embodiments where some degree of manual control is still required by an operator. Manual control can provide safety advantages over a fully automated system; as such the present invention should not be seen to be limited to machines that are fully automated, instead automation may be provided in part for non-safety critical processes or processes that are not desirable to automate or to simply provide greater flexibility over the control of the produce processing machine. In some cases a fully automated produce processing machine may provide full manual control as an option.

The control system for both fully automated and full, or partially, manually controlled machines will typically be configured at the time of commissioning. The configuration will typically include detail of what additional equipment is attached to the machine and the peak processing capacity of the machine, i.e. drum and brush speed and load maximums. The examples provided below are the sequences that would be performed for the installation of Figure 1 for a fully automated system, Figure 3, and a manually controlled system Figure 4.

Typically the control system, whether automated or manually controlled, will require an operator to manually enter a start command. The start command may be issued remotely from a control
room to the control system. In such cases the start command will be overridden by the control system if any safety interlocks associated with the produce processing machine are not engaged. For example, access panel latch interlocks, fluid level float switches or the like.

An example of the fully automated process is shown in the flow diagram of Figure 3. The control system begins by detecting 100 whether the downstream chute/drying roller 15, 16, inspection conveyor 17 and roller sizer 18 are activated. In some embodiments the produce processing machine 1 control system remotely connects to a master control system, which will typically be located in a control room, and which allows remote starting of downstream equipment and optional checking and control of the running speed of each of the pieces of downstream equipment. In some embodiments if any equipment is not activated or is not running at the desired speed the control system aborts the routine and notifies the operator of the reason the routine was aborted.

If a recycle base 13 is fitted, the control system checks 101 whether the fluid level in the recycle base 102 is within a pre-defined range. If the fluid level is within the range the recycle pump and filter screen are started 107, 108 and cleaning fluid flows within the produce processing machine. If additional fluid is required, i.e. the fluid level is too low, the control system activates a water inlet valve, or, if too much fluid is present the control system activates a drain pump. In either case draining or filling continues until the fluid level is within the pre-defined range. If no recycle base is fitted, or, once the recycle base is running, the drum and brush variable speed drives are activated 109. Under no-load conditions, i.e. no produce is present in the produce processing machine 1, the control system will typically run the drum and rollers at a speed that is defined by the retrieved operating profile.

Once the drum and rollers are at the pre-defined speed 110 the control system activates the hopper conveyor 111 to feed produce into the produce processing machine 1.

The retrieved profile may include details of the brush and drum load settings, inflow rate and exit gate angle. As produce is fed into the produce processing machine 1 the speed of the drum and rollers decreases due to the loading from the produce. The control system then adjusts the speed of the drum and brush variable speed drives to achieve the maximum loading defined by the retrieved profile as well as adjusting the speed of the hopper conveyor and the angle of the exit gate in accordance with the retrieved profile and in order to maximise the throughput of produce thorough the machine. Maximum throughput will typically be defined as a percentage of maximum motor load or current rating.

In some embodiments the routine may be completed in a number of ways, including:

- the operator manually terminating the routine;
the control system detecting a decrease in drum and brush load due to the amount of produce in the processing machine reducing;

an upstream hopper issuing a hopper-empty signal.

In some preferred embodiments the control system implements a turn off cycle in which the control system may:

- run for a pre-defined period of time to clear produce from the machine; and/or
- adjust the angle of the exit gate 14 to allow any remaining produce to pass through the machine.

In addition to selecting an automated routine, the operator of a fully automated machine may choose to manually control the control system, or manually override aspects of the retrieved profile. Manual intervention may be useful for situations such as when the processed produce requires more, or less, processing than the retrieved profile provides. In such cases the operator will observe either under, or over processed produce passing through the exit gate.

An example showing the process of a manually controlled system is shown in Figure 4. As with the fully automated process the operator will typically input the necessary data for the control system to identify and retrieve a profile 200 in an associated memory. For the manually controlled process the retrieved profile may include a number of pre-defined set points that correspond to an initial setup of, for example, the speed of the downstream chute/drying roller 15, 16, inspection conveyor 17, roller sizer 18, fluid levels for recycle base 13 if one is fitted.

The controlled system displays 201 the pre-defined setpoints defined by the retrieved profile as well as the current positions, levels or statuses that each pre-defined setpoint corresponds to. The operator than manually adjusts the produce processing machine so that the current positions, levels or statuses are substantially equal to a corresponding pre-defined setpoint. Manual adjustment may be controlled by operator interaction with the control system, or by activating mechanical or electrical switches, valves or the like. Once the machine has been adjusted to the correct setpoints the operator manually starts the machine 202.

Starting of the machine 202 will typically start the hopper conveyor 12 which feeds produce into the produce processing machine. As the hopper conveyor starts feeding produce into the machine the machine checks 204 that machine is not operating above its maximum capacity.

The utilisation of the machine is displayed to the operator, this will typically be a percentage of full load capacity which indicates to the operator whether the machine throughput can be increased. The operator can then manually adjust 206, 210 one or more of the machine setpoints, such as, for example, the drum speed, brush speed, exit gate angle, infeed rate or the like. After any manual adjustment 206 the machine checks 204 that the maximum capacity of the machine has not been exceeded. If the maximum capacity of the machine has been
exceeded the operator is alerted 209 and the machine warns the operator of the overload status. Typically the machine will continue running and will alert the operator, although in some embodiments the machine may automatically control the machine to reduce the overload condition. As a rule the maximum capacity will be pre-defined at a level below the true operating limit of the machine.

With manually operated machines the routine will typically be completed by the operator manually terminating the routine.

In both fully automated and partial, or fully, manually controlled embodiments the control system also monitors the machine operating hours, loading, and consumption of water and power. This information is useful for scheduling preventative maintenance cycles, cleaning cycles, and brush/drum reversal. Preferably cleaning and maintenance cycles are recorded, including details of the operator who performed the maintenance/cleaning.

Unless the context clearly requires otherwise, throughout the description and the claims, the words "comprise", "comprising", and the like, are to be construed in an inclusive sense as opposed to an exclusive or exhaustive sense, that is to say, in the sense of "including, but not limited to".

The entire disclosures of all applications, patents and publications cited above and below, if any, are herein incorporated by reference.

Reference to any prior art in this specification is not, and should not be taken as, an acknowledgement or any form of suggestion that that prior art forms part of the common general knowledge in the field of endeavour in any country in the world.

The invention may also be said broadly to consist in the parts, elements and features referred to or indicated in the specification of the application, individually or collectively, in any or all combinations of two or more of said parts, elements or features.

Where in the foregoing description reference has been made to integers or components having known equivalents thereof, those integers are herein incorporated as if individually set forth.

It should be noted that various changes and modifications to the presently preferred embodiments described herein will be apparent to those skilled in the art. Such changes and modifications may be made without departing from the spirit and scope of the invention as defined in the appended claims, and without diminishing its attendant advantages. It is therefore intended that such changes and modifications be included within the present invention.

**ALTERNATE WAYS TO IMPLEMENT THE INVENTION**
Load sensing may be provided in a number of ways, including, but not being limited to, a combination of one or more of current consumption, speed, torque, temperature, vibration and weight. In some embodiments one or more of the load sensing parameters may be provided within third party electronics such as the variable speed controllers that control the drum and brush motors.

In some preferred embodiments the processor is configured to automatically control the speed of rotation of the drum based on the drum load sensing.

When the drum is rotating with no produce in the machine the drum speed may be excessive at a given torque, or the pre-defined torque value may not be able to be attained. Alternatively, speed sensing alone will not provide certainty that the variable speed drive is operating within its design parameters. For example if the produce is particularly heavy or a large amount of produce is inadvertently fed into the produce processing machine, the torque on the variable speed drive might be excessively high at a particular speed. For this reason, although sensing of a single parameter such as speed or torque could be performed a combination of a number of parameters provides a significantly higher level of feedback to the control system.

Some preferred embodiments of the automated produce processing machine may include a brush speed sensor rather than a brush torque sensor. Other embodiments may include a combination of both torque and brush speed sensing.

Some preferred embodiments of the automated produce processing machine may include either, or both of, a drum direction sensor and a brush direction sensor in communication with the processor. The direction sensors may be provided in a number of non-limiting ways, examples of which may include optical or magnetic sensors or a logic state stored in a memory associated with the control system.

In some preferred embodiments the produce processing machine may be stand alone, that is to say it does not have any control of the upstream or downstream equipment. In such cases the control system is able to dynamically control the drum and brush speed, as well as the angle of the exit gate, to achieve a desired processing rate which matches the in feed rate. This may be achieved in a number of ways, non-limiting examples of which include monitoring the variable speed drive speeds and/or torque/load, or the inflow and outflow rates.

In some embodiments the rate at which cleaning fluid is dispensed within the machine is controllable. In such embodiments a variable rate fluid dispenser such as a solenoid operated water jet or the like is provided.

Where a drain pump is activated by the control system a number of different activation triggers may be used, non-limiting examples of which include, a period of time lapsing, a number of machine cycles passing or a manual activation of a draining cycle.
Non-limiting examples of equipment that the control system may automatically activate include conveyors, feed gates, monitoring tables, recycle bases, pumps, water reticulation pumps (fresh water vs recycled water), spray bars, and in-feed and out-feed spray nozzle combinations, or the like.

Some preferred embodiments may include a plurality of inputs from associated equipment to the control system. Non-limiting examples of equipment and the signals they may provide include fluid tanks which provide an indication of fluid level; hoppers that provide a weight or product present indication; recycle bases that provide fluid level indications, overload indicators or fluid viscosity warnings; conveyors which provide speed or enabled signals, emergency stop signals, safety interlock signals such as access panel open/closed sensors or the like.

The exit gate acts as a barrier against which produce backs up. Once the depth of produce exceeds the height of the exit gate produce flows over the barrier and out of the produce processing machine. It will be appreciated that the exit gate could be implemented in a number of ways without departing from the scope of the present invention, for example a variable height wall could be used rather than the rotatable guide chute.

In some preferred embodiments the processor data-logs aspects of the produce processing machine operating status. Examples of aspects that may be logged include, but should not be limited to, machine running hours, average loading, water consumption, power usage, fresh water flow and recycled water flow. In some embodiments the logged aspects may be used to, for example, generate automatic maintenance reminders, reverse the drum and brush rotation directions, and/or to initiate automated cleaning cycles.

In some preferred embodiments the produce processing machine processor includes inputs for one or more drum load, drum speed; brush load; brush speed; brush direction and drum direction. Preferably the processor has a pre-defined value for each input stored in a memory associated with the processor, wherein one or more outputs of the processor are varied depending on the input(s).

Nonlimiting examples of how the inputs may be used include:

- Drum load may be used by the processor to adjust an output associated with a variable speed drive associated with the drum to increase or decrease the speed of the drum.

- Drum speed may be used by the processor to adjust an output associated with a variable speed drive associated with the drum to increase or decrease the speed of the drum.
• brush torque may be used by the processor to adjust an output associated with a variable speed drive associated with a brush to increase or decrease the speed of the brush.

• a brush speed sensor may be used by the processor to adjust the output associated with a variable speed drive associated with a brush to increase or decrease the speed of the brush.

• a brush direction sensor may be used by the processor to adjust an output controlling the direction of rotation of the brushes.

• a drum direction sensor may be used by the processor to adjust an output controlling the direction of rotation of the drum.

• a fluid level sensor may be used by the processor to adjust, activate or deactivate an output controlling one or more of a recycle pump, a drain pump and/or a scavenge pump. In some embodiments multiple fluid level sensors may be used.

In some preferred embodiments an automated feeder supplying produce to the produce processing machine may be controlled by the produce processing machine control system. The infeed rate may be adjusted by the control system based on a number of operating characteristics measured from the running produce processing machine. Non limiting examples of such characteristics include the measured drum or brush torque, the measured drum or brush speed, a desired throughput rate, a limitation in the rate of cleaning fluid application. In such embodiments the operating characteristic of the produce processing machine is compared with a pre-defined value for the operating characteristic stored in a memory associated with the processor, the rate at which produce is fed into the produce processing machine is then adjusted to achieve the pre-defined value of that operating characteristic.

In manually operated embodiments the machine may sound or display a warning if the produce polishing machine reaches its pre-defined maximum capacity and is at risk of stalling.

Some preferred embodiments may also limit operator manual control to prevent any further increase in loading from being added. In such embodiments the operator will only be able to manually adjust the machine in a way that reduces the loading.

In embodiments that include an automatic fluid dispenser and associated flow rate sensor, the produce processing machine may measure the rate of flow fluid flow and compare that measured rate of fluid flow with a pre-defined value of fluid flow stored in a memory associated with the processor; if the measured rate of flow and pre-defined rate of flow do not match the processor may adjust the fluid flow rate. If the maximum available flow is still less than the pre-defined value of fluid flow the rate of produce processing may be automatically reduced to a maximum throughput for the available fluid flow rate.
In embodiments that include an output configured to provide automated activation of associated equipment, the processor may require an operating characteristic of the produce processing machine to match a pre-defined value for that operating characteristic. For example, prior to activating an infeed conveyor the drum and brush speed of the produce processing machine must be within a range, the water level must be sufficiently high and the fluid flow rate of cleaning fluid must be within specification.

In preferred embodiments the processor includes one or more routines that include pre-defined values relating to the operation of the machine. Preferably a routine relates to a particular produce type and desired process to be performed on the produce.

In some preferred embodiments the control system may include a communications interface for transmitting and receiving signals to a remote terminal, such as, for example, a laptop, desktop or mobile computing device.

Preferably the a laptop, desktop or mobile computing device is capable of indicating a status of the produce processing machine and in some embodiments providing remote control of the produce processing machine.
WHAT WE CLAIM IS:

1. An automated produce processing machine having a rotating drum defined, in part, by a plurality of cylindrical brushes, the automated produce processing machine having:
   • drum load sensing associated with a drum of the produce processing machine;
   • a drum variable speed drive configured to rotate the drum;
   • a control system having a processor configured to:
     o monitor the drum load, and
     o compare a measured drum load to a pre-defined drum load value stored in a memory associated with the processor; and
     o display to an operator an indication of operating capacity versus a pre-defined maximum operating capacity for the machine which includes a comparison between the measured drum load and the pre-defined drum load value.

2. The automated produce processing machine of claim 1 wherein the pre-defined drum load value defines a maximum safe drum loading level.

3. The automated produce processing machine of either one of claim 1 or claim 2, wherein the plurality of rotating brushes are rotated by one or more brush variable speed drives.

4. The automated produce processing machine of claim 3, including a brush load sensor in communication with the processor.

5. The automated produce processing machine as claimed in claim 4, wherein the indication of operating capacity versus a pre-defined maximum operating capacity for the machine includes a comparison between the measured brush load and a pre-defined brush load value.

6. The automated produce processing machine of any one of claims 1 to 5 including an automated fluid dispenser in communication with the processor, the processor configured to adjust the rate of application of the fluid.
7. The automated produce processing machine system of any one of claims 1 to 6 including a drain pump, the processor configured to control the drain pump on and off.

8. The automated produce processing machine system of any one of claims 1 to 7 including a recycle pump, the processor configured to control the recycle pump on and off.

9. The automated produce processing machine of any one of claims 1 to 8 including a scavenge pump, the processor configured to control the scavenge pump on and off.

10. The automated produce processing machine of any one of claims 1 to 9 including an output configured to provide automated activation of associated equipment.

11. The automated produce processing machine of any one of the preceding claims including an automated outflow gate for controlling the outflow rate of produce from the automated produce processing machine.

12. The automated produce processing machine of any one of claims 1 to 11 wherein the processor provides data-logging of the produce processing machine operating status, including one or more of machine running hours, average loading, water consumption, power usage, fresh water flow and recycled water flow.

13. The automated produce processing machine of any one of claims 1 to 12 wherein the logged data is used to generate automatic maintenance reminders.

14. A method of operating an automated produce processing machine having a rotating drum defined, in part, by a plurality of cylindrical brushes, the automated produce processing machine having drum load sensing associated with a drum of the produce processing machine, a drum variable speed drive configured to rotate the drum, a control system having a processor configured to monitor the drum load and adjust the speed of the variable speed drive based on the sensed load, the method including the steps of:

   g) measuring a drum load by way of the drum load sensing;

   h) comparing the measured drum load to a pre-defined drum load value stored in a memory associated with the processor; and

   i) displaying to an operator an indication of operating capacity versus a pre-defined maximum operating capacity for the machine which includes a comparison between the measured drum load and the pre-defined drum load value.
15. The method of claim 14, wherein the plurality of rotating brushes are rotated by one or more brush variable speed drives.

16. The method as claimed in claim 15, wherein the produce processing machine includes a brush load sensor in communication with the processor, the method including the steps of:
   j) measuring a brush load by way of the brush load sensor;
   k) comparing the measured brush load to a pre-defined brush load value stored in a memory associated with the processor; and
   l) displaying to an operator an indication of operating capacity versus a pre-defined maximum operating capacity for the machine which includes a comparison between the measured brush load and the pre-defined brush load value.

17. The method as claimed in any one of claims 14 to 16, wherein the processor measures one or more operating characteristics of the produce processing machine and records the measured one or more operating characteristics to a memory associated with the processor.

18. A control system for use with a produce processing machine having a rotating drum defined, in part, by a plurality of cylindrical brushes, the automated produce processing machine having a drum load sensor associated with a drum of the produce processing machine, a drum variable speed drive configured to rotate the drum, the control system including:
   • a processor;
   • a memory associated with the processor;
   • a plurality of inputs, one of the plurality of inputs being a drum load sensing input configured to monitor the drum load;

wherein the controller is configured to monitor an input associated with the drum load sensing, compare the sensed drum load with a pre-defined drum load value stored in the memory and outputting a signal representing the difference between the sensed drum load and the pre-defined drum load value.

19. The automated produce processing machine of claim 18, wherein the plurality of rotating brushes are rotated by one or more brush variable speed drives.

20. The control system of claim 19, wherein one of the plurality of inputs is the brush load.
21. The control system of claim 20, wherein the controller is configured to monitor the input corresponding to the brush load, compare the sensed brush load with a pre-defined brush load value stored in the memory and outputting a signal representing the difference between the sensed brush load and the pre-defined brush load value.
Retrieve Profile

Display Status of Associated Equipment

Start Demand

Begin Infeed

Maximum Capacity Reached

Alert Operator

Adjust Towards Setpoint

Display Utilisation

Manual Setpoint Adjustment

Routine Complete

End Profile

Figure 4
INTERNATIONAL SEARCH REPORT

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)

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

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

TXPEA, TXPEB, TXPEC, TXPEE, TXPEF, TXPEH, TXPEI, TXPEP, TXPEPEA, TXPES, TXPUSEOA, TXPUSEIA, TXPUSEA, TXPUSEB, TXPWOEA, EPODOC, WPIAP: IPC's and CPC's ( /IC/CC) (A23N, A22C29, A47J21, A47J23, A47J25, G05D, GOIG, G05B) and keywords (control, drum, load, weight, sense, rotate, compare, produce, vegetable, fruit and similar terms).

Google Patents, Espacenet: Keywords (fruit, vegetable, produce, process, clean, wash, brush, rotate, load, weight, sense, control, processor and similar terms).

Applicant(s)/Inventor(s) search conducted on Espacenet, AusPat and all internal databases provided by IP Australia.

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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X Further documents are listed in the continuation of Box C

X See patent family annex

* Special categories of cited documents:
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Date of the actual completion of the international search: 27 January 2016
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